NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

AN ANALYSIS OF ALTERNATE ACCESSION SOURCES FOR NAVAL OFFICERS

by

Joel P. Bernard

March 2002

Thesis Advisor: Stephen L. Mehay
Thesis Co-Advisor: William R. Bowman

Approved for public release; distribution is unlimited

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
29 Mar 2002	N/A	-

Title and Subtitle An Analysis of Alternate Accession Sources for Naval Officers	**Contract Number**
	Grant Number
	Program Element Number
Author(s) Bernard, Joel	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Naval Postgraduate School Monterey, California	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es)	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes	
Abstract	
Subject Terms	
Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 104	

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.			
1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** March 2002	**3. REPORT TYPE AND DATES COVERED** Master's Thesis	
4. TITLE AND SUBTITLE: An Analysis of Alternate Accession Sources for Naval Officers			**5. FUNDING NUMBERS**
6. AUTHOR(S) Joel P. Bernard			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			**12b. DISTRIBUTION CODE**

13. ABSTRACT ***(maximum 200 words)***

This thesis analyzes the effect of commissioning source on the retention and promotion outcomes of Naval officers to the O-4 promotion point. In particular, this thesis analyzes difference in the joint probabilities of retention and promotion for officers from each commissioning program. This study identifies improved measures of Navy officer performance and the relative cost-effectiveness of each commissioning program.

A database of the career milestones and productivity indicators for Navy officers from year groups 1983-1990 has been created from NODC information and annual promotion board results through the career milestone point O-4. Multinomial logit models of retention and promotion are specified to estimate the independent effect of accession sources on URL and RL officer retention and promotion outcomes. Using an assumed steady-state flow of officers, differences in promotion and retention outcomes at various grades are used to estimate the number of accessions associated with producing a single O-4 from each commissioning program. Total lifecycle costs required to retain and promote these officers to the O-4 point are calculated and used as the basis for the cost-effectiveness analysis.

The results suggest that for URL officers USNA is generally the most cost-effective commissioning program, but that the ROTC-Contact may be underutilized.

14. SUBJECT TERMS: Officer Accession Sources, Officer Commissioning Programs, Officer Retention, Officer Promotion, Cost-Effectiveness Analysis			**15. NUMBER OF PAGES** 104
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UL

NSN 7540-01-280-5500 Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

AN ANALYSIS OF ALTERNATE ACCESSION SOURCES FOR NAVAL OFFICERS

Joel P. Bernard
Lieutenant, United States Navy
B.S., United States Naval Academy, 1995

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
March 2002

Author: Joel P. Bernard

Approved by: Stephen L. Mehay
Thesis Advisor

William R. Bowman
Thesis Co-Advisor

Douglas A. Brook, Ph.D.
Dean, Graduate School of Business and public Policy

THIS PAGE INTENTIONALLY LEFT BLANK

ABSTRACT

This thesis analyzes the effect of commissioning source on the retention and promotion outcomes of Naval officers to the O-4 promotion point. In particular, this thesis analyzes differences in the joint probabilities of retention and promotion for officers from each commissioning program. This study identifies improved measures of Navy officer performance and the relative cost-effectiveness of each commissioning program.

A database of career milestones and productivity indicators for Navy officers from year groups 1983-1990 has been created from Navy Officer Data Card information and annual promotion board results through the career milestone point O-4. Multivariate logit models of retention and promotion are specified to estimate the independent effect of accession source on URL and Restricted Line officer retention and promotion outcomes. The logit models control for other determinants of retention and promotion such as undergraduate experience and capital investment. Using an assumed steady-state flow of officers, differences in promotion and retention outcomes at various grades are used to estimate the number of accessions associated with producing a single O-4 from each commissioning program. Total lifecycle costs required to retain and promote these officers to the O-4 point are calculated and used as the basis for the cost-effectiveness analysis.

The cost-effectiveness outcomes depend on whether marginal or average costs are used. However, the results suggest that for URL officers USNA is generally the most cost-effective commissioning program, but the ROTC-Contact program may be underutilized. Additionally, the results do not support the belief that having a technical degree is critical to success in the Navy.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

ACKNOWLEDGMENTS

I would like to acknowledge those individuals who provided their dedicated guidance and support throughout this thesis:

Professor Stephen L. Mehay – for his guidance, insightful advice and help, not only throughout the duration of this thesis, but my entire stay at NPS.

Professor William R. Bowman – for his time and assistance in compiling the data used in this thesis. His cost-effectiveness studies and insight were the basis for my analysis of the Navy's commissioning programs.

Dennis Mar – for his time and assistance in the early stages of coding the data used in this thesis.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

The Navy spends millions of dollars to meet their annual requirement of newly commissioned officers. However, to date, very few comprehensive analyses of these programs have been undertaken. In absence of such analyses, Department of Defense (OSD) decision makers lack a theoretical or empirical framework for evaluating these programs, and for making tradeoff decisions among alternate commissioning programs. Currently, the demand for experienced and more senior Unrestricted Line (URL) officers is expected to grow. In order to make trade-off decisions and incremental increases in accessions in response to this demand, the Navy's leadership needs to know if one accession source is producing a specific community of officers at a rate less costly than another accession source. The United States Naval Academy (USNA) is believed to be the premier commissioning program for increased future accessions (Parcell, 2001). The results in this thesis may signal a need to access more of these officers to fill personnel shortages that cannot be met by the ROTC program, and would otherwise require additional OCS accessions. This research will provide OSD with reliable, scientifically verifiable, measures of the costs and benefits of the Navy's officer commissioning programs.

Historically, the U.S. Naval Academy has been the premier source of regular commissioned officers. Since World War II, a secondary source of regular commissioned officers became institutionalized through the Navy Reserve Officer Training Corps (NROTC) program (Bowman, 1995). The combination of USNA and NROTC's competitive scholarship program have been the foundation of the Navy's highly trained, technically proficient corps of career officers. A third commissioning program, Officer Candidate School (OCS), was institutionalized nearly 30 years ago to meet accessions shortages not met by the Naval Academy and NROTC programs. The OCS program currently provides a substantial number of accessions in both URL and Restricted Line officer communities by direct appointment of carefully screened college graduates.

In the early 1990's, there was significant congressional debate concerning the Navy's officer accession programs. In particular, proposals were made to close the Naval Academy due to the high education and training costs associated with each USNA graduate, relative to substantially lower pre-commissioning costs for NROTC and OCS accessions. Since this time, various studies have sought to analyze the Navy's officer commissioning programs to determine the economic benefits and cost-effectiveness of each program.

This thesis will use the economic theory of human capital investment in order to provide the framework for evaluating these commissioning programs. The human capital model treats education and training programs as strategic investments that yield a stream of future returns. The application of this theory will be consistent with previous studies that empirically have examined the relationship between military officer on-the-job productivity and commissioning source and various educational programs. By analyzing lifecycle productivity profiles of a sample of Navy officers, the economic benefits of officer commissioning programs and the associated economic costs of these programs can be assessed. Economic benefits will be measured in terms of increases in productivity, while economic costs will be measured as opportunity costs of foregone productivity.

The human capital model will further assist in answering the primary and secondary research issues of this thesis. The primary research issue is simply to identify measures of program impact to evaluate the effectiveness of each commissioning program. The secondary research issue is to assess the cost and value of these programs to the Navy. Again, answers to these issues will be useful to Navy decision makers who face the challenge of meeting future demand for an increased number of more senior officers. The methodology developed in this thesis uses logit retention and promotion models and steady state cost analysis as the foundation for evaluating each alternate commissioning program. To this end, officer retention and promotion to the O-4 career point have been chosen as the two primary measures of program impact.

A database of the career milestones and productivity indicators for Navy officers has been created for use in this study. The database consists of Navy Officer Data Card

information and annual promotion board results through the career milestone point O-4, in order to analyze the difference in the joint probabilities of retention and promotion for officers from each commissioning source. The analysis will track officer retention and promotion for each officer from pay grade O-1 to O-4. Using an assumed steady-state flow of officers, the differences in the promotion and retention outcomes at various grades will be used to estimate the number of accessions associated with producing a single O-4 from each alternate accession source. Total lifecycle costs required to retain and promote these officers to the O-4 point will be calculated and used as the basis for the cost-effectiveness analysis.

Both the cost and performance measures typically used in prior studies cited are reviewed first in this thesis. This review is followed by a description of the data and methodology used in this thesis to analyze performance differences. Preliminary analysis of retention and promotion rate differentials of officers from different commissioning programs and communities is discussed in Chapter IV. Regression models of officer retention and promotion outcomes are developed in Chapter V. These models estimate the effect of accession source, undergraduate experience, and human capital investment on officer retention and promotion outcomes. Given the retention and promotion rate differentials discussed in Chapter IV, and the multivariate regression results in Chapter IV, the number of accessions required to maintain a given steady state endstrength and force structure will be calculated. The steady state number of accessions provide the basis for the cost-effectiveness analysis of commissioning sources presented in Chapter VI. This thesis hopes to identify improved measures of Navy officer performance and identify any potential cost savings that may be generated by making changes in policies regarding the mix of officer accessions from different commissioning programs.

THIS PAGE INTENTIONALLY LEFT BLANK

II. LITERATURE REVIEW

The review of relevant literature of prior analyses of officer accession sources should begin with discussion of salient effectiveness measures that have been based to describe the retention and promotion of Naval officers. Prior studies have used pre-commissioning costs and career survival rates as the basis for evaluating the cost-effectiveness of alternate commissioning programs. Such analyses do not account for the Navy's investment in its officers as assets that generate a flow of future returns. The economic theory of human capital is a fundamental concept underlying the evaluation of cost-effectiveness models of officer accessions. This chapter of the study identifies prior analyses that use pre-commissioning cost, mean length of service, and survival rates as measures of officer performance, while providing examples of current studies that have used human capital investment theory.

A. WEAKNESSES IN PRIOR COST ANALYSES OF COMMISSIONING SOURCE

Pre-commissioning costs for each commissioning source must be interpreted carefully. The underlying criticism of prior cost studies is that pre-commissioning costs can be calculated either on the basis of average costs or marginal costs. Knowing the average cost of commissioning an officer is useful in examining a commissioning program that operates at full capacity with specified overhead costs, normally treated as efficiency training costs. Historically, the United States Naval Academy (USNA) and the Officer Candidate School program (OCS) have operated at full capacity. Average pre-commissioning training costs associated with these programs have been based on the full cost of administering the program, regardless of incremental changes in the USNA midshipman brigade or OCS class size. In the case of the Reserve Officer Training Corps ROTC, average pre-commissioning costs account for both the cost of administering the program at each public or private college and university, as well as the cost of tuition per person. However, average cost would not be indicative of the incremental costs associated with increasing or decreasing officer accessions by some specified amount from a given commissioning program in order to meet expected personnel or readiness shortages and surpluses. For the latter purpose, marginal costs would have to be

calculated. That is, the change in marginal costs must be used, for example, if one is examining expanding or contracting the Brigade of Midshipman at USNA by 1000 students.

Various studies have attempted to compare officer commissioning programs by using either average or marginal cost, yet it is important to note there are substantial differences between these two cost concepts. Average costs account for what the Navy has actually spent on each graduate from each program, while marginal costs can be seen as the cost associated with making incremental changes to the size of each accession program. In a recent 2001 study, the Center for Naval Analyses computed the marginal cost of producing an accession from three different commissioning programs. These marginal costs were computed to be: USNA = $121,000; ROTC = $132,000; and OCS = $58,000 (Parcell, 2001). However, in a different study, average costs for these same three programs in 1990 were reported to the Congressional Budget Office as follows: USNA = $153,000; ROTC = 53,000, and OCS = $20,000 (Bowman 1995). Despite not inflating the 1990 CBO cost estimates to 2001 dollars, there are noticeable differences between relative average and marginal costs, not only between 1990 and 2001, but also between commissioning programs. Looking at the marginal costs would lead a policy maker to believe an ROTC accession would cost relatively more than a USNA accession and more than twice that of an OCS accession. The average cost data, on the other hand, suggests that the cost of a USNA graduate is three times that of an ROTC graduate, and seven times that of an OCS graduate. This thesis will discuss both average and marginal costs later in the steady state cost chapter.

One criticism of prior studies is that most cost analyses only account for pre-commissioning costs. By not accounting for differences in post-commissioning training costs, these studies do not provide enough information to the accessions decision maker to accurately judge cost-effectiveness. Additionally, the study must distinguish between historical average costs and the current marginal costs associated with incremental accession changes. Differences in pre-commissioning costs impact cost-effectiveness decisions more in communities where post-commissioning education and training costs are low (eg., SWO, SUB) relative to communities where education and training costs are high (eg., Pilot, NFO) (Bowman, 1995).

Another criticism of prior analyses is the potential aggregation bias that may exist when commissioning sources are evaluated as a whole and not by warfare or restricted line community. Some studies have committed aggregation bias in statistics based on the mean length of service of officers from different accession sources (Mackin and Darling, 1996). These studies have generally found that measures of officer job tenure do not vary by commissioning source, yet these measures are aggregated for entire commissioning programs and do not account for differences related to the type of community (Bowman, 1995). If there are differences in either mean length of service, retention rates, or even promotion rates between both restricted and unrestricted line communities, for example, it does not seem reasonable to evaluate the Navy's officer commissioning programs with this method. Similarly, using a mean value as a statistic for gauging length of service is not useful in making career milestone comparisons of officers from different accessions sources. Comparisons of mean length of service are not as valuable as knowing percentages of accessions that stay to the O-3 (LT), O-4 (LCDR), or O-5 (CDR) and beyond point.

Many officer cost studies rely on survival rates as a measure of officer performance (Parcell, 2001). These survival rates reflect the percentage of officers that remain on active duty from one year to next. However, they do not account for promotion differences between communities of officers, nor do they account for true voluntary decisions to remain on active service, when officers are not under obligation. As there are substantial differences between the length of obligated service for unrestricted line officers (pilots, naval flight officers, submarine officers and surface warfare officers) it is not reasonable to compare survival rates of communities, just as it is not reasonable to compare survival rates of accession sources by the same method.

Perhaps the most important problem with the use of survival rates as a measure of officer performance is that decision makers are unable to determine why an officer chooses to leave the Navy and what factors influence the stay or leave decision. Additionally, it is important to note that as the Navy's current officer corps has experienced the effects of a military draw-down in the early 1990's, survival rates of these officers would not distinguish between officers that chose to leave and those officers that were forced out due to decreased promotion or command opportunities.

In summary, prior analyses of the cost-effectiveness of commissioning programs have failed to develop accurate measures of the costs of producing an officer at a designated career milestone. Neither average or marginal pre-commissioning costs alone, nor statistics for mean length of service, nor survival rates, are capable of predicting true measures of program impact: retention and promotion probabilities for an individual officer. Since the measures developed in prior studies do not account for retention and promotion differences, there is no way to apply a cost analysis that provides an accessions planner with a framework for evaluating different commissioning programs. The next section of this thesis will identify recent studies that have used the human capital model as it relates to organizational investment decisions and econometric techniques for evaluating officer retention and promotion.

B. PRIOR STUDIES OF OFFICER RETENTION AND PROMOTION

1. Study by Cymrot on Graduate Education

In his 1986 study, "Graduate Education and the Promotion of Officers," Donald J. Cymrot (Cymrot, 1996) states that an individual officer's productivity can be measured by indicators such as performance evaluations, retention, and promotion. In his study, he uses a binary logit model to estimate and evaluate the effects of fully-funded graduate education on Navy officer promotions. In his models, he uses officer promotion as the dependant variable, since he argues that promotion to the ranks of O-4 through O-7 is a valuable measure of an officer's productivity throughout their career.

Cymrot's study can be questioned for a lack of true cohort data; rather, he used cross-sectional data from the 1985 Officer Master File. Also, sample selection bias may be present in the study because he failed to account for retention differences between the officers in the data sample who have stayed in the Navy to various career points. Despite these shortcomings, he did construct a valuable framework for evaluating promotion probabilities of Navy officers. In addition to including explanatory variables for graduate education, he included demographic variables to account for differences in race, gender, and age in his model. He also included variables for service designator in his logit models.

Cymrot's study indicates that graduate education did in fact increase the probability of promotion to the next higher rank. The computed effect of graduate education was both statistically significant and positive for the ranks O-4 through O-6. Cymrot also found that older officers were more likely to promote than younger officers in the data set.

Although Cymrot's study did not provide the cost-analysis framework that will be required and developed in this study, it did identify measures of program impact (officer promotion) that can be used to evaluate the effectiveness of different commissioning programs. Cymrot's study also provides valuable insight into computing the partial effect of each explanatory variable on the binomial dependent variable in a logit model. One calculation involves comparing an individual with a set of selected characteristics to individuals with the same base case characteristics. A key difference between the type of logit model used in this thesis and Cymrot's logit model is the inclusion of both demographic and human capital explanatory variables. This allows for promotion comparisons between individuals in the same community, but who were accessed under different commissioning programs.

2. Study by Mehay on the Impact of Race/Ethnicity on Junior Officer Performance

In his 1995 equal opportunity study for the Office of the Secretary of Defense (OSD), "Analysis of Performance Data for Junior Navy and Marine Corps Officers," Stephen L. Mehay (Mehay, 1995) analyzes the career paths of junior USN and USMC officers in order to identify differences in both career progress and measured performance between minority and non-minority officers. He uses data from of an updated version of the Navy Officer Promotion History Data File merged with data from separate files containing background characteristics, work experience, and other factors for O-3 promotion boards between fiscal years 1981 through 1985, and O-4 promotion boards between fiscal years 1985 through 1990. By merging these data files, he was able to accurately identify officers who voluntary separated from the Navy or Marine Corps.

Unlike Cymrot, Mehay used the econometric technique of bivariate probit analysis to estimate the maximum likelihoods for the binary dependent variables, retention and promotion. His empirical analysis specified and estimated probit models of

on-the-job-performance, where job performance was a function of cognitive skills, affective non-academic skills, and other demographic characteristics. The study attempted to determine what portion of observed performance differences were directly related to race and which observed performance difference were the result of other characteristics. Mehay's explanatory variables were associated with four distinct groupings: 1) college background; 2) personal demographics; 3) fitness report performance; and 4) Navy experience.

Mehay found that the effects of race/ethnicity were masked by the effects of other variables in the model and that the direct effect of minority status is reduced when other variables that are correlated with race/ethnicity (and an interaction variable for school selectivity) are included in the set of explanatory variables. Mehay also found that the effect of minority status on promotion was negative due in part to a negative effect of minority status on fitness report ratings. He concluded that it was extremely difficult to model the relationship between race/ethnic background and career success because causality could not be inferred between race and performance based solely on the results of the probit models.

Instead, Mehay proposed that pre-commissioning intervention and accession policies were probably the best way to address observed race or ethnicity performance differences. In his discussion of the Surface Warfare community, he presented the argument that lower minority performance evaluations were based on lower warfare qualification rates, and that lower qualifications rates could be traced all the way back to class rankings in college and resultant initial ship assignments. In the case of junior Marie Corps officers, he concluded that lower promotion outcomes for minorities resulted from background characteristics, such as GCT scores and previous performance, vice a direct effect associated with race or ethnicity.

3. Study by North and Smith on Impact of Race/Ethnicity on Marine Corps Officer Promotion

In a 1993 CNA study, "Officer Accession Characteristics and Promotions to Captain and Major," North and Smith (North and Smith, 1993) used a different approach than Cymrot in trying to estimate the effect of race and ethnicity on the promotion rates of Marines to the ranks of O-3 and O-4. Unlike Cymrot, who only looked at graduate

education and promotion in a binomial logit model, North and Smith used a series of bivariate probit models to evaluate the joint probability that a Marine officer would both stay on active service until a given promotion board and would be promoted at the board.

In order to evaluate both retention and promotion, North and Smith created a data file who include longitudinal The Basic School (TBS) Files for all Marine officers that attended post-commissioning training in Quantico, Virginia between 1980 and 1991, and then merged those files with O-3 and O-4 promotion board results for those same cohorts. This allowed the authors to evaluate retention in a bivariate probit model for all officers who were accessed. A probit promotion model was then used to evaluate the sample of officers that remained on active duty at the time of the O-3 and O-4 promotion boards. The bivariate probit estimation technique accounts for selection in the promotion outcome that is associated with the retention decision. That is, the characteristic of stayers may be systematically different from leavers and thus may bias estimated coefficients.

North and Smith included demographic explanatory variables (age, race, marital status, and prior enlisted service) in their probit models as well as explanatory variables to account for an individual's military occupational specialty (MOS). North and Smith also created variables for accession source, as well as control variables for promotion board year, to account for varying cohort size and promotion opportunities among 12 different year groups. Important to note in these promotion results, however, is that although 12 year groups were contained in the data set, only 4 year groups (1980-1983) could be evaluated for O-4 promotion (9.5 year point) at the time of the study.

In terms of promotion results by accession source, North and Smith found that USNA and ROTC graduates had higher probabilities of promotion and were more likely to promote to O-3 and O-4 than officers from other accession sources. Additionally, North and Smith concluded that while Black and other minority Marine officers were less likely to be promoted to O-3, none of the race variables were statistically significant in the O-4 promotion models. Interestingly, they found that although promotion rates appear lower for black officers, controlling for background characteristics reduces the difference in promotion probability by more than half at the O-3 board, and completely eliminates

the difference in promotion probability at the O-4 board. This result was similar to that of Mehay for Navy officers.

Coincidentally, as is the case with many retention and promotion studies, North and Smith found that marital status and MOS impact both the decision to stay on active duty and the probability of promotion. Both explanatory variables were statistically significant and the results concluded that married officers were more likely to promote to both O-3 and O-4, and Marine aviators were more likely to promote to O-3 and O-4 than officers with other occupational specialties in the data set.

4. Study by Bowman on Cost-Effectiveness of Service Academies

William R. Bowman's 1995, "Cost-Effectiveness of Service Academies: New Evidence from Navy Warfare Communities,"(Bowman, 1995) is the only prior study of alternate accession sources that applies a cost analysis to the different commissioning programs in a steady state environment. This study provides the methodology that is applied in this thesis. Bowman's study analyzes both retention and promotion probability differences between warfare and restricted line communities with the use of econometric probit models. He analyzes the effect of both demographic and human capital variables on the retention and promotion of URL and restricted line officers in year groups 1976 through 1981. Similar to the studies of Mehay and North and Smith, he merges actual cohort Officer Data Card information with promotion and selection board results.

Bowman develops a fundamentally different measure of effectiveness from other studies. This measure is the number of newly commissioned officers required to replace those officers who leave active duty, either voluntarily or involuntarily, in a steady state environment at given career points. He computes the steady state accessions necessary to replace a group or community of officers from a single accession source based on the retention and promotion rates for the group. A simple example of this methodology is as follows: If 1000 pilots were accessed in a single year group from commissioning source A, and 200 of those pilots promote to O-4 (at 10 years of service) at first look (in-zone or below-zone), then the steady state number of pilot accessions for source A = 1/.20 = 5.0. That is, to maintain a flow of officers that ensures there will be 1,000 pilots available at year 10, the Navy must access 5,000 new pilots at entry.

Bowman uses the computed steady state number of accessions to evaluate three different commissioning programs (USNA, ROTC, and OCS) in four URL communities (Surface, Submarine, Pilot, and NFO.) He further computes total discounted lifecycle costs per officer as the product of total discounted training costs (pre-and post commissioning) and steady state accession requirements. The justification for this type of cost analysis is based on the Navy's front-loading of human capital investments early in an officer's career with the expectation that the Navy will realize economic returns on their investment in the form of longer job tenure and higher levels of productivity. Bowman further states that since one cannot monetize the value of the productivity of officers over their careers, he replaces cost-benefit analyses with a cost-effectiveness analysis.

Table 23 (p. 94) of his study has been reproduced in Table 1 to demonstrate how discounted lifecycle costs are calculated. The required number of accessions are shown in column 4 and life cycle costs are displayed in column 5. This methodology will be the basis for all cost analyses developed in this thesis.

Bowman's results show that USNA graduates have a higher propensity to remain on active duty and to promote in-zone in two of the four URL communities (Submarine and Pilot). The turnover rates of USNA accessions require less up-front human capital investments to be made by the Navy. These figures also support the belief that the Navy is making a cost-effective investment decision in spending an average of nearly $200,000 on the undergraduate costs of USNA graduates. Conversely, the Navy does not get the same return on its investment in OCS accessions, despite spending only $28,523 in pre-commissioning training costs, due to significantly higher turnover rates of OCS graduates compared to USNA and ROTC graduates. Also important to note in these results is that Bowman found OCS graduates to be the most cost-effective source for the Surface Warfare officers, but ROTC to be the most cost-effective source for NFO's.

Table 1. Calculations of Discounted Lifecycle Costs.

DISCOUNTED LIFECYCLE COSTS OF PRE-AND POST-COMMISSIONING HUMAN CAPITAL INVESTMENTS REQUIRED TO MAINTAIN STEADY STATE BY COMMUNITY AND SOURCE (IN 1994 DOLLARS)

COMMUNITY AND SOURCE	DISCOUNTED COSTS			NUMBER OF ACCESSIONS	DISCOUNTED LIFECYCLE COSTS
	PRE-COMMISSIONING	POST-COMMISSIONING	TOTAL		
SUBMARINE:					
USNA	187,808	130,519	318,327	5.42	1,725,332
ROTC	76,731	120,757	197,488	9.58	1,891,935
OCS	35,951	110,761	146,712	21.45	3,146,972
SURFACE:					
USNA	187,808	94,708	282,516	6.91	1,952,186
ROTC	76,731	84,578	161,309	11.82	1,906,672
OCS	35,951	79,251	115,202	14.76	1,700,382
PILOT:					
USNA	187,808	1,124,102	1,311,910	7.40	9,708,134
ROTC	76,731	1,102,705	1,179,436	9.96	11,747,183
OCS	28,523	1,075,021	1,103,544	14.12	15,582,041
NFO:					
USNA	187,808	1,270,529	1,458,337	8.97	13,081,283
ROTC	76,731	1,262,641	1,339,372	8.65	11,585,568
OCS	28,523	1,260,213	1,288,736	13.73	17,694,345

NOTES:

1. Pre-commissioning costs taken from Table 17, post-commissioning costs from Table 22.
2. Number of accessions required to maintain steady state (column 5) taken from Figures X-XIII.
3. Discounted lifecycle costs (column 6) derived as the product of total discounted costs (column 4) and the number of accessions (column 5).

From: [Bowman, 1995. “Cost-Effectiveness of Service Academies: New Evidence from Navy Warfare Communities”, Table 23, p. 94]

Finally, in answering the question whether service academies are worth the price, Bowman found that, in general, maintaining ROTC units and the Naval Academy reduces both turnover costs related to voluntary quits, and involuntary separations required to maintain endstrength and force structure numbers. ROTC and USNA commissioning programs develop more firm-specific human capital during the pre-commissioning training period, therefore reducing voluntary separations and making officers from those programs more productive in the fleet compared to officers accessed through OCS. Bowman also acknowledges the finding that the voluntary stay or leave decision prior to the O-4 promotion board was largely unrelated to commissioning source or pre-commissioning training for USNA graduates and more likely to be related to an individual's marital status and initial experience in the fleet while serving in their initial obligated service. This finding is similar to that of North and Smith, as the effects of marital status and fleet experience seem to dominate and even reduce the pre-commissioning retention and promotion differentials in these econometric models.

THIS PAGE INTENTIONALLY LEFT BLANK

III. DATA AND METHODOLOGY

A. DATA DESCRIPTION

Data for this thesis were collected from several different sources by William R. Bowman, Economics Department, U.S. Naval Academy. The data consists of Navy Officer Data Card Information for both Unrestricted and Restricted Line Officers in year groups 1983 through 1990. These files were identified by social security number and merged with current O-3 (LT) and O-4 (LCDR) selection and promotion board results from fiscal years 1986 through 2001.

The data file consisted of 295 personal characteristics for each officer accessed under five different commissioning programs. The initial data file contained records on 25,212 officers. Observations with missing critical data were removed from the sample; 2,934 observations were deleted from the file due to missing academic proficiency codes (APC) relating to undergraduate grade point average. Additionally, a commissioning age criterion was established, so that only officers between 20 and 30 years of age at commission were retained. The data file included a very small number of officers that fell below 20 years of age, and older than 35 years of age at commissioning; 15 observations were deleted from the file due to these criteria. After these deletions, 17,134 URL observations and 5,129 Restricted Line observations remained in the data file for analysis.

As specified in Bowman (1995), exclusion of cases that have no observed value for important explanatory factors introduces potential bias into a study. In this thesis, 2,934 observations (15% of total sample) were deleted due to missing academic proficiency codes. These numerical codes are assigned by the Naval Postgraduate School to identify undergraduate academic proficiency in three areas: the grade point average of all undergraduate courses taken for credit, grades obtained in mathematics (calculus-based) courses, and grades obtained in physics based science and engineering courses. These three proficiency codes are used for selection and screening purposes of fully funded graduate education at the Naval Postgraduate School in Monterey, California and several civilian universities. As academic and educational achievement are signs of

increased knowledge and skill, these academic proficiency codes also serve as a signal of superior ability and performance (Woodhall, 1987), which are likely to influence the retention and promotion outcomes of officers. APC1 as a measure of grade point average is an important explanatory variable in the logit retention and promotion models developed in this thesis. Bias arises if the officers with missing APC codes are systematically different from those with APC codes.

Sample selection bias may affect parameter estimates in multivariate models due to retention decisions made by officers. Retention to the O-4 board in this thesis is defined as the voluntary decision to stay or leave active duty service to the 10-year point. Minimum service requirements (MSR) for year groups 1983 through 1990 ranges from four years to seven years. Thus, most of the officers in the data file used here were free to make a voluntary stay-leave decision. The only exception would be pilots and Naval Flight Officers (NFO's). In this data, pilots and NFO's experienced varied obligated service, from six to seven years beginning after their warfare "winged" qualification date. Consequently, a substantial portion of these officers were still serving their MSR at the time they appeared at the O-4 promotion board. Additionally, MSRs for both pilots and NFOs were dependent on type of aircraft selected while in the secondary phase of the aviation training program. Statistics for years of commissioned service at completion of MSR were not available for analysis for any observations in the data file. Therefore, an unidentified percentage of aviators may not have made a true voluntary stay/leave decision prior to the O-4 board.

In an attempt to control for aggregation bias, the retention and promotion models are estimated separately for URL and Restricted Line (RL) officers. Within the URL community, separate promotion models were estimated for three individual URL communities (Surface, Submarine, and Aviation) and one RL group. The hypothesis behind this sorting is that different communities experience different retention and promotion behavior and different factors affect both the retention and the promotion of these groups of officers. This hypothesis is based on the results of Bowman (1995). The next section of this thesis will discuss model specification and dependent and independent variables used in the logit models.

B. MODEL SPECIFICATION

Model specification is based on Bowman (1995), Mehay (1995), and Bowman and Mehay (2002). Non-linear logit models of retention and promotion are specified to estimate the individual (partial) effect of accession sources separate from demographic, pre-commissioning, and post-commissioning characteristics. The logit models allow analysis of the change in the dependent variable (retention or promotion to O-4) with respect to a change in a specific explanatory variable, (ceteris paribus) holding the effect of all other explanatory variables in the model constant. The hypothesis about the relationship between the explanatory variables and the dependent variables is believed to be non-linear, therefore a logit model is used for analysis of retention and promotion probabilities. Interpretation of all logit model results will be discussed in Chapters IV and V of this thesis.

C. VARIABLE DESCRIPTION

Variables are grouped into the following categories: Outcomes, Demographics, Human Capital, College Selectivity, Community Designators, and Control Variables. Table 2 lists each variable from the Accession Cohort Samples (URL and Restricted Line) and its description. The variable description corresponds to how each dependant and explanatory variable was coded.

1. Outcomes

The two outcomes analyzed in this thesis are STAY04BD and HPROM04. STAY04BD is the dependent variable that captures whether or not an officer stayed on active service to the O-4 promotion board; STAY04BD = 1 if the officer stayed, and STAY04BD =0 if the officer either voluntarily or involuntarily left the Navy prior to appearing before the O-4 promotion board (at 9.5 years of commissioned service on average). The HPROM04 variable distinguishes whether or not the officer promoted to O-4 at first look if they remained on active service. Promotion at first look is defined in this thesis as those officers that promote "in-zone" or "below-zone." HPROM04 =1 for those officers that promoted at first look; HPROM04 =0 for officers that either failed to promote to O-4 or promoted "above-zone".

Table 2. Variable Name and Description, Grouped by Category.

VARIABLE	DESCRIPTION
Outcomes	
STAY04BD	= 1 IF SURVIVED TO O-4 BOARD; = 0 OTHERWISE
HPROM04	= 1 IF PROMOTED TO O-4 AT FIRST LOOK; = 0 OTHERWISE
Demographics	
AGE_COMM	AGE AT COMMISSIONING (IN YEARS)
WHITE	= 1 IF RACE IS WHITE; = 0 OTHERWISE
BLACK	= 1 IF RACE IS BLACK; = 0 OTHERWISE
OTHER	= 1 IF RACE IS NOT WHITE OR BLACK; = 0 OTHERWISE
FEMALE	= 1 IF GENDER IS FEMALE; = 0 IF MALE
SNC	= 1 IF SINGLE WITH NO CHILDREN; = 0 OTHERWISE
SWC	= 1 IF SINGLE WITH CHILDREN; = 0 OTHERWISE
MNC	= 1 IF MARRIED WITH NO CHILDREN; = 0 OTHERWISE
MWC	= 1 IF MARRIED WITH CHILDREN; = 0 OTHERWISE
Human Capital	
SOMEPRIOR	= 1 IF 1 TO 4 YRS ACTIVE ENLISTED TIME; = 0 OTHERWISE
TECHMAJ	= 1 IF UNDERGRADUATE MAJOR IS TECHNICAL; = 0 OTHERWISE
USNA	= 1 IF ACCESSION SOURCE IS USNA; = 0 OTHERWISE
ROTCS	= 1 IF ACCESSION SOURCE IS ROTC SCHOLARSHIP; = 0 OTHERWISE
ROTCC	= 1 IF ACCESSION SOURCE IS ROTC CONTRACT; = 0 OTHERWISE
OCS	= 1 IF ACCESSION SOURCE IS OCS; = 0 OTHERWISE
ECP	= 1 IF ACCESSED UNDER ECP WITH ROTC SCHOLARSHIP; = 0 OTHERWISE
NAPC1	ORDINAL (0-5). ACADEMIC PROFILE CODE (UNDERGRADUATE GPA)
NAPC2	ORDINAL (0-6). ACADEMIC PROFILE CODE (CALCULUS EXPERIENCE)
NAPC3	ORDINAL (0-6). ACADEMIC PROFILE CODE (ENG/PHYSICS EXPERIENCE)
College Selectivity	
TOPCOLL	= 1 IF COLLEGE ATTENDED IS HIGHLY SELECTIVE; = 0 OTHERWISE
MIDCOLL	= 1 IF COLLEGE ATTENDED IS SELECTIVE; = 0 OTHERWISE
LOCOLL	= 1 IF COLLEGE ATTENDED IS NOT SELECTIVE; = 0 OTHERWISE
Community Designators	
SWO	= 1 IF SURFACE WARFARE OFFICER; = 0 OTHERWISE
SUB	= 1 IF SUBMARINE OFFICER; = 0 OTHERWISE
AIR	= 1 IF PILOT OR NFO; = 0 OTHERWISE
SPECWO	= 1 IF SPEC WARFARE OR SPEC OPS OFFICER; = 0 OTHERWISE
SUPPLY	= 1 IF SUPPLY CORPS OFFICER; = 0 OTHERWISE
FLTSUPP	= 1 IF FLEET SUPPORT OFFICER; = 0 OTHERWISE
RLSO	= 1 IF RESTRICTED LINE, NOT SUPPLY OR FLT SUPPORT; = 0 OTHERWISE
Control Variables	
YRG83	= 1 IF ACCESSED IN YEAR GROUP 1983; = 0 OTHERWISE
YRG84	= 1 IF ACCESSED IN YEAR GROUP 1984; = 0 OTHERWISE
YRG85	= 1 IF ACCESSED IN YEAR GROUP 1985; = 0 OTHERWISE
YRG86	= 1 IF ACCESSED IN YEAR GROUP 1986; = 0 OTHERWISE
YRG87	= 1 IF ACCESSED IN YEAR GROUP 1987; = 0 OTHERWISE
YRG88	= 1 IF ACCESSED IN YEAR GROUP 1988; = 0 OTHERWISE
YRG89	= 1 IF ACCESSED IN YEAR GROUP 1989; = 0 OTHERWISE
YRG90	= 1 IF ACCESSED IN YEAR GROUP 1990; = 0 OTHERWISE

2. Demographics

Each study reviewed above in Chapter II used a combination of demographic variables to explain variation in either retention or promotion rates. The sociological norms of the Navy, as well as structural differences in professional opportunities, (particularly promotion and retention), within military organizations all impact the behavior of individuals of different age, gender, race, and family status. (Branigan, 2001)

AGE_COMM is a continuous variable that reflects an officer's age at the time of commission. Officers who are older at the time of commission are sometimes considered more mature than younger officers, and may be more productive in their initial tours of service. Higher age at commission may also reflect prior enlisted service. Increased productivity would indicate higher levels of professional success and expertise than less productive officers, and therefore may not only promote at higher rates than younger officers, but may experience higher retention rates due to increased military satisfaction during those initial tours.

The variables WHITE, BLACK and OTHER are all binary variables that reflect an officer's race or ethnicity. The variable OTHER indicates any race listed in the individual's Officer Data Card information other than white or black. North and Smith (1993), Mehay (1995), and Bowman (1995) all found that minority status impacts retention behavior, as well as promotion to either O-3 or O-4.

The variable FEMALE is a binary variable that reflects an officer's gender. FEMALE =1 indicates the officer is female, while FEMALE = 0 indicates the officer is male. This explanatory variable is another reason that supports separating URLs from Restricted Line Officers in the LOGIT analysis. Although females make up less than 5% of the total sample of URLs, they represent 32% of Restricted Line officers.

SNC, SWC, MNC, and MWC are all binary variables that reflect an officer's combined marital and dependent status. SNC corresponds to single officers with no children, while SWC reflects single officers with children. MNC reflects married officers that have no children, and MWC reflects married officers that have at least one child. North and Smith (1993), and Bowman and Mehay (1999) found that married officers were more likely to promote to O-4 in the Navy and Marine Corps than officers who

were single. North and Smith (1993) also concluded that married officers were more likely to stay to the O-4 selection board than single officers.

3. Human Capital Indicators

Variables were constructed to group officers into one of five different accession source categories. This thesis creates commissioning source variables to distinguish between USNA, ROTC Scholarship, ROTC Contract, OCS, and ECP accessions. This is a different specification than Bowman (1995), Bowman and Mehay (2002), and Parcell (2001), who use USNA, ROTC and OCS as the three accessions categories in their studies, and find that USNA graduates are more likely to promote and remain on active service beyond O-4 than officers from ROTC and OCS. Data was available to distinguish ROTC contract and ECP officers from the entire sub-sample of officers who attended ROTC training. ECP officers in this case had served at least one tour of active enlisted service and participated in ROTC training. Using five categories of accession source instead of three also made it possible to identify retention and promotion differences among three different groups of officers that would have otherwise been grouped into a single ROTC category, even though the cost of each of these programs differs considerably.

TECHMAJ and the three NAPC variables reflect an officer's undergraduate academic experience. Bowman and Mehay (2002) found that officers with undergraduate degrees in engineering, mathematics, science, and business were more likely to promote to O-4 than those with humanities degrees. For the purpose of this thesis, technical majors were considered to be officers with degrees in engineering, mathematics, and science. Economics, business, political science and all other humanities majors were considered non-technical. As the URL communities are considered technically demanding duty, it is believed that having a technical degree increases an officer's performance and promotion opportunity. However, Bowman (1990) and Bowman and Mehay (2002) found little support for the hypothesis that a technical degree is necessary for success in the Navy, despite URL communities emphasizing the policy of requiring officers with technical degrees.

The three APC variables are believed to have similar effects on retention and promotion. APC scores of 0 and 1 correspond to higher academic achievement, thus greater pre-commissioning performance and ability. NAPC1 as a measure of GPA may also have a signaling effect to senior raters as post-commissioning ability. It is important to note that the NAPC1 scale is reversed: values of 0 correspond to higher GPA's, while an NAPC1 score of 5 indicates a low undergraduate GPA.

SOMEPRIOR is another binary variable that reflects whether or not an officer completed any active enlisted service prior to being commissioned. Since retention and promotion in this thesis will be evaluated only to the O-4 promotion board, two different hypotheses exist about the relationship between prior enlisted service and retention. Officers with prior service may be less likely to stay to the O-4 promotion board if they have served 20 years of combined service and are eligible for retirement before reaching the O-4 board career point. Conversely, officers with prior service have more experience in the fleet and may be more productive and better assimilated into the Navy's organizational culture. Wielsma (1996) found that prior enlisted officers were more likely to remain on active service until the O-4 board, but less likely to promote to O-4. I expect that officers with prior enlisted service will be more likely to retain and promote to O-4 than officers with no prior service.

4. College Selectivity

Bowman and Mehay (2002) found that Navy officers who graduated from top rated private schools receive better performance ratings during the early career period and are more likely to promote at the up-or-out point (historically the O-4 board). The three variables constructed for college selectivity (TOPCOLL, MIDCOLL, LOCOLL) reflect the selectivity of an officer's undergraduate college, as ranked by Barron's publication, "Profiles of American Colleges." Barons ranked these colleges on a scale of 1 to 6, with a ranking of 1 corresponding to "most selective" and a ranking of 6 corresponding to "least selective." The variable TOPCOLL consisted of observations with a Barron's score of 1 or 2. The variable MIDCOLL consisted of observations with a Barron's score of 3 or 4. Observations with Barron's scores of 5 or 6 were identified as LOCOLL. These college selectivity variables were not included in the set of explanatory variables

for the retention and promotion models; however, the variable TOPCOLL was used to construct a commissioning program/selectivity interaction variable.

5. Community Designators

North and Smith (1993), Bowman (1995) and Wielsma (1996) found that aviators were more likely to be promoted to O-4 than officers from other occupational categories. Four URL categories have been constructed in this thesis to reflect officers serving in Surface Warfare, Submarine Warfare, Aviation, and Special Warfare-Operations communities. Similarly, three variables have been constructed to reflect Restricted Line Officers in three separate groups: the Supply Corps, Fleet Support, and Restricted Line Staff/Other. For the purpose of all retention models, the specific community corresponds to the officer's designator at the time of the O-3 promotion board. O-4 board designators could not be determined for officers that left prior to the O-4 board, therefore the last recorded designator on record was at the time of the O-3 board. Community distinctions in all promotion models in this thesis correspond to the officer's designator at the O-4 board.

6. Control Variables

An attempt has been made to control for otherwise non-measurable factors (e.g., promotion rate opportunities from year to year, year group size differentials, effects of the personnel and equipment drawdown in the early 1990's) affecting officer promotion and retention that are not directly attributable to other explanatory variable in the model. To this end, a series of year group dummy variables were constructed and included in all promotion and retention models (YRG83-YRG90) to indicate the fiscal year of an officer's promotion board. No interpretation of magnitude or statistical significance will be included in the logit model results. However, these variables are necessary to account for timing of various events and outside economic conditions in an officer's career. These variables also account for the different precepts of promotion boards from one year to the next, allowing isolated analysis of the effects of the other explanatory variables in the logit model.

D. INTERACTION VARIABLES

Five variables have been constructed in this thesis to reflect officers that attended highly selective colleges and universities. As noted earlier, Bowman and Mehay (2002) found that graduates of top rated schools were more likely to promote at the up-or-out point. Interaction of accession source by the TOPCOLL variable that identifies only highly selective colleges allows analysis and comparison between USNA graduates and accessions of all other programs that attended highly selective schools. USNA is considered a highly selective undergraduate institution, therefore all accessions from USNA are represented by USNATOP. Table 3 identifies the variable name and description of these five interaction variables. The variable USNATOP identifies all USNA graduates, while RSTOP identifies ROTC-S graduates of highly selective colleges, and RCTOP, OCS TOP, and ECPTOP identify graduates of each commissioning program who attended highly selective colleges.

Table 3. College Selectivity and Commissioning Source Interaction Variables.

VARIABLE	DESCRIPTION
Source/Selectivity Interaction	
USNATOP	= 1 IF SOURCE IS USNA; = 0 OTHERWISE
RSTOP	= 1 IF ROTCS AND COLLEGE IS HIGHLY SELECTIVE; = 0 OTHERWISE
RCTOP	= 1 IF ROTCC AND COLLEGE IS HIGHLY SELECTIVE; = 0 OTHERWISE
OCSTOP	= 1 IF OCS AND COLLEGE IS HIGHLY SELECTIVE; = 0 OTHERWISE
ECPTOP	= 1 IF ECP AND COLLEGE IS HIGHLY SELECTIVE; = 0 OTHERWISE

E. ACCOUNTING FOR LATERAL TRANSFERS

A literature review of all prior econometric studies that identified officers by community or designator indicated no prior study had analyzed the effect of changing designator on retention and promotion. Therefore, seven variables were included in the retention and promotion models to account for lateral transfer of officers from one community to another. These variables are listed in Table 4. I expect that lateral transferring to another community identifies dissatisfaction with initial community selection, so than an officer who lateral transfers may be more inclined to stay until the O-4 board, and may promote at a higher rate than they would if they had stayed in their original community. The seven variables correspond to changes either into or out of the

specified community. Voluntary lateral transfers could not be distinguished from involuntary reassignment due to non-achievement of warfare qualifications or training pipeline dropouts. As was the case with community designator variables, retention models reflect designator changes prior to the O-3 board, while promotion models reflect designator changes prior to the O-4 board.

Table 4. Designator Change and Lateral Transfer Variables.

VARIABLE	DESCRIPTION
Lateral Transfer Traits	
LAT_TO_SWO	= 1 IF LATERAL FROM OTHER URL TO SWO ; = 0 OTHERWISE
SWO_2_URLO	= 1 IF LATERAL FROM SWO TO OTHER URL; = 0 OTHERWISE
LAT_TO_SUB	= 1 IF LATERAL FROM OTHER URL TO SUB; = 0 OTHERWISE
SUB_2_URLO	= 1 IF LATERAL FROM SUB TO OTHER URL; = 0 OTHERWISE
LAT_TO_AIR	= 1 IF LATERAL FROM OTHER URL TO PILOT OR NFO; = 0 OTHERWISE
AIR_TO_URLO	= 1 IF LATERAL FROM PILOT OR NFO TO OTHER URL; = 0 OTHERWISE
URL_LATS	= 1 IF LATERAL FROM URL TO RESTRICTED LINE; = 0 OTHERWISE

IV. DATA ANALYSIS

A. URL RETENTION RATES

Before developing multivariate models to estimate the effects of accession source and other human capital measures on retention and promotion of Naval officers to LCDR, we first identify differences in the retention rates of officers from various commissioning programs and communities. This section of the thesis examines retention rates by community, accession source, and year group.

As noted in Chapter II, it maybe inappropriate to combine accession sources or officer communities when deriving a statistic to show officer propensity to stay in the Navy. (Bowman 1995) In an attempt to control for this potential aggregation bias, officer observations in this thesis have been grouped according to large identifiable categories. Preliminary analysis of the Navy's accession sources suggested the five main categories: USNA, ROTC Scholarship, ROTC-Contract, OCS, and ECP. Previous accession source studies have used only three commissioning source distinctions: USNA, ROTC, and OCS. (Bowman, 1995 and Parcell, 2001). The categories ROTC-Contract and ECP were added in this thesis to determine whether officers from these commissioning programs retain and promote at higher rates than ROTC-Scholarship accessions.

Within the year groups represented by the data sample (1983-1990), officers selected for ECP who participated in ROTC training were an average 4.3 years older at the time of commission than their ROTC-Scholarship counterparts. ECP accessions also had an average of 2.9 years active enlisted service, whereas their ROTC-Scholarship counterparts had no previous work experience in the Navy. Additional distinctions were evident between ROTC-Contract officers and ROTC-Scholarship officers. ROTC-Contract accessions paid an average of $10,008 (2002 dollars) per year in undergraduate tuition costs, and voluntarily participated in ROTC training in return for a guaranteed commission. In previous studies that analyzed accession source data, officers who accessed via ROTC-Contract or ECP were included in a single, all-encompassing ROTC category. However, explanatory factors like higher age, prior service, and attachment to military service have all been linked to increased productivity and higher rates of

retention in the fleet. These differences made it necessary to separate ROTC-Contract and ECP accessions from ROTC-Scholarship accessions.

Accessions were further analyzed by individual year group in order to identify differences in officer retention prior to, and after, the military draw-down of the early 1990's that drastically reduced Navy end strength, total assets (ships, aircraft, bases), and command opportunities. Cross-tabulations of URL retention by commissioning source are shown in Table 5 below and the associated graph (Figure 1). Of the four commissioning sources listed, USNA and ROTC-Contract (ROTC-C) show significantly higher retention rates to O-4 than ROTC-Scholarship (ROTC-S) and OCS. The sample mean retention rates in Table 5 indicate ROTC-C and USNA accessions stay to the O-4 board at a rate 7% higher than ROTC-S and OCS. The rates for each source are: ROTC-C= 44.8%, USNA=43.7%, ROTC-S=36.7%, and OCS=35.6%.

It can also be seen that year groups 1986 and 1987 experienced lower than average retention. This drop in retention can be explained again by the impact of the draw-down in 1992 and 1993. Year groups 1986 and 1987 were approximately at the six and seven-year point in their careers during this draw-down period, and most had completed their minimum service requirement and were free to make a voluntary leave decision. Additionally, officers in the earlier year groups were eligible for voluntary separation incentive payments under the VSI (Voluntary Separation Incentive) and SSB (Selective Separation Bonus) programs.

While Table 5 identifies differences in URL retention rates between accession sources, comparisons to ECP could not be evaluated due to small sample sizes: only 108 ECP observations were contained in the URL sample of 17,135 observations. These 108 observations were not uniformly distributed between the eight year groups, therefore there was significant variation in ECP retention rates from one year to the next. Despite not being able to evaluate ECP accessions by year group, it is important to note that 50 of 108 (46.3%) ECP URL's remained on active service until the O-4 promotion board.

It is essential to note that a bias may exist in data represented in Table 5. Year group 1983 contains only a small percentage (approximately 20%) of the actual officers accessed in that year, and no USNA accessions from year group 1983 were contained in

the data sample. Only 492 observations from year group 1983 were contained in the original data file, while all other year groups contained at least 2,000 observations. The sample mean retention rate for USNA is based only on year groups 1984 through 1990. Sample mean retention rates for ROTC-S, ROTC-C, and OCS are based on year groups 1983 through 1990. Despite this limitation, multivariate retention analysis will not be adversely affected as 1990 is used as the basis for comparison in all logit models estimated in Chapter V. Year group 1990 and all other year groups, with the exception of 1983, contained representative URL accessions.

Table 5. URL Retention Frequencies by Source (Year Groups 1983-1990) (% Stay to LCDR Promotion Board).

SOURCE	YEAR GROUPS								SAMPLE MEAN
	83*	84	85	86	87	88	89	90	
USNA	0	43.4%	47.1%	39.8%	39.2%	41.5%	43.9%	51.4%	43.7%
ROTC-S	47.6%	38.8%	38.8%	35.6%	32.2%	35.0%	38.0%	41.0%	36.7%
ROTC-C	43.5%	49.5%	43.8%	38.9%	41.4%	43.1%	51.5%	47.3%	44.8%
OCS	30.9%	37.1%	33.1%	34.5%	35.8%	33.8%	39.8%	44.5%	35.6%

***Year Group 1983 contained no accessions from USNA.**

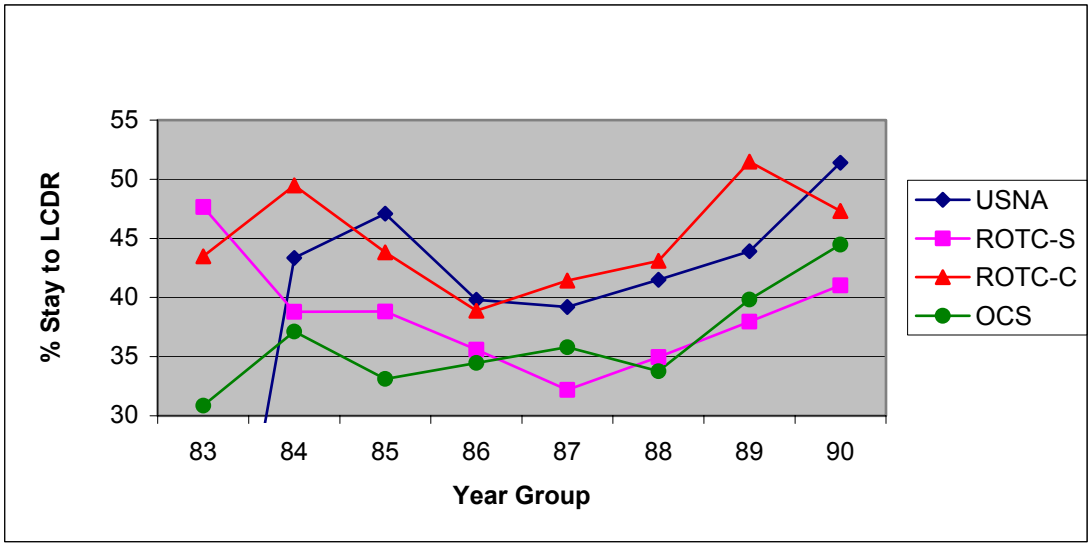

Figure 1. URL Retention Frequencies by Commissioning Source.

Table 6 compares URL retention rates among three identifiable community categories: Surface (SWO), Submarine (SUB), and Aviation (AIR). In this thesis, the Aviation (AIR) category combines pilots and NFO's. Combining these two communities introduces a potential aggregation bias into the study; however, it is hypothesized that these two groups experience similar patterns of retention behavior with regard to length of MSR, bonus and pay structures, and command opportunities. Significantly higher investment in human capital made by the Navy during the post-commissioning training period of all aviators distinguishes them from the Submarine and Surface Warfare Officer communities.

Similar to ECP accessions, the category Special Warfare-Operations (SPECWO) is not represented in the table due to small sample sizes and non-uniform distribution across year groups. As a whole, there were 214 observations in the data sample for the SPECWO category. As an average retention rate, 105 of 214 (49.1%) Special Warfare and Special Operations Officers remained on active duty to the O-4 promotion board.

Table 6 and Figure 2 show Submariner retention rates fluctuated between 24.5% in 1986 and 32.5% in 1984. The SUB community had the lowest amount of variation in retention rates in the eight year groups listed. The variation between highest and lowest retention rate by community are: SUB = 8% point, compared to SWO (11.8% points), and AIR (18.3% points). Compared to SWO, the mean SUB retention rate to the O-4 board is 4.5% points higher. AIR retention appears very high in comparison to SWO and SUB; however, as noted in Chapter III, a substantial and unidentifiable portion of these officers have not made a voluntarily stay/leave decision prior to the O-4 board due to lengthy MSR obligations. The sample mean retention rate for AIR is 50.5%; however, Bowman (1995) finds that this rate varies greatly according to accession source. His analysis of pilots and NFO's in year groups 1977 through 1985 indicate that the actual pilot stay rates to O-4 were: USNA=58.0%, ROTC=54.9%, and OCS=36.4%; (NFO) USNA =63.1%, ROTC=65.8%, and OCS=62.9%. This thesis will identify retention rate by source and community as part of the process of determining the required steady state flow of accessions in the cost analyses in Chapter VI. An unbiased and more accurate analysis of the aviation community will be presented in part B of this chapter, in comparison to URL promotion rates by community.

Table 6 and Figure 2 show that the Surface community experienced the lowest retention rates of the three URL communities. An important statistic to note here is that almost 39% of the Surface Warfare Officers who stayed to the O-4 promotion board lateral transferred to SWO from another community after O-3 selection, or failed out of their initial training program and entered the surface community prior to O-3 selection. Table 7 identifies the 921 officers who transferred into the Surface community and stayed to the O-4 board. Table 8 identifies the 1,130 Surface Warfare Officers who lateral transferred to SWO from another URL or Restricted Line community after attaining a warfare qualification. No other URL community experienced lateral transfer gains and losses of this magnitude; however, further multivariate analysis of the effect of lateral transferring into and out of a specific community is examined in the logit model results in Chapter V of this thesis.

Table 6. URL Retention Frequencies by Community (Year Groups 1983-1990) (% Stay to LCDR Promotion Board).

COMMUNITY	YEAR GROUP								SAMPLE MEAN
	83	84	85	86	87	88	89	90	
SWO	32.3%	31.1%	26.3%	22.9%	20.5%	21.5%	25.2%	21.5%	24.2%
SUB	32.4%	32.5%	31.5%	24.9%	25.6%	24.5%	27.5%	28.7%	28.7%
AIR	43.0%	49.7%	45.8%	47.3%	50.8%	53.2%	55.2%	61.3%	50.5%

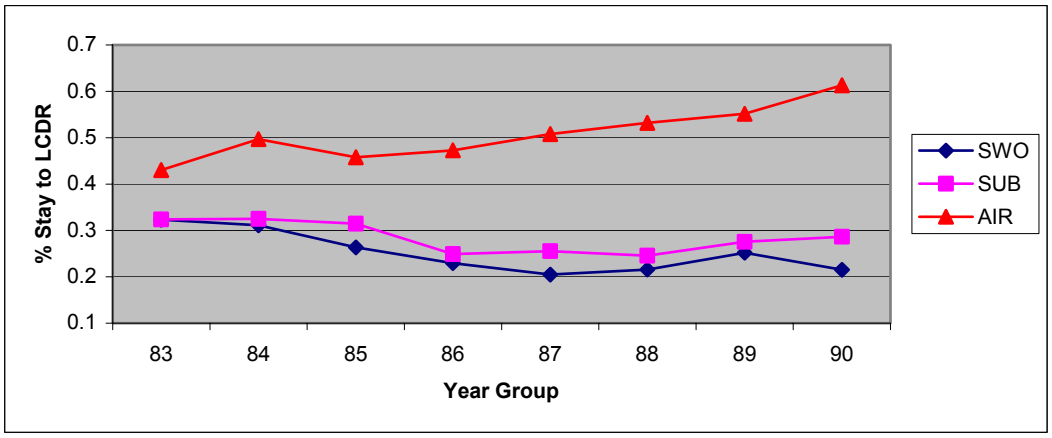

Figure 2. URL Retention by Community (Year Groups 1983-1990).

Table 7. SWO Lateral Transfers In.

TRANSFERS TO SWO THAT STAYED TO O-4 BOARD	
PROGRAM FAILURES	**NUMBER**
Nuclear Power	82
Aviation-Pilot	64
Aviation -NFO	39
BUDS/SEAL	1
Diver/EOD	4
LATERAL TRANSFERS	
Fleet Support	714
Other Restricted Line	5
Submarine	4
Pilot	5
NFO	1
Diver/EOD	2
Total Transferred In	921

Table 8. SWO Lateral Transfers Out.

URL AND RL STAYERS THAT STARTED IN SURFACE	
LATERAL TRANSFERS OUT	**NUMBER**
Pilot	61
NFO	43
Submariner	19
Diver/EOD	26
SEAL	17
Fleet Support	633
Restricted Line Other	331
Total Transferred Out	1130

B. URL PROMOTION RATES

Table 9 and Figure 3 compare the promotion rates of URL's by the four categories of commissioning programs (USNA, ROTC-S, ROTC-C, and OCS). These results appear much different than those seen in Table 5. USNA remains the most competitive in the percentage of accessions who promoted to LCDR at first look (sample mean = 71.3%). OCS accessions consistently promote at higher rates than accessions from ROTC-Scholarship and ROTC-Contract: OCS = 69.4%, ROTC-S= 63.7%, and ROTC-C = 63.6%. An accurate analysis of these OCS accessions would be that they

have poor retention rates from the time of commission, but that those officers who stay to the O-4 board promote at a rate nearly 6 points higher than ROTC-S and ROTC-C.

Table 9. URL Promotion to LCDR by Accession Source.

SOURCE	YEAR GROUP								SAMPLE MEAN
	83*	84	85	86	87	88	89	90	
USNA	0	71.9%	77.8%	70.9%	71.0%	65.0%	66.7%	74.8%	71.3%
ROTC-S	74.5%	64.0%	67.0%	57.5%	62.1%	60.0%	62.7%	73.0%	63.7%
ROTC-C	80.0%	55.3%	63.0%	62.9%	58.7%	70.0%	69.2%	61.4%	63.6%
OCS	73.6%	74.1%	71.0%	68.3%	64.8%	69.9%	67.3%	68.1%	69.4%

***Year Group 1983 contained no accessions from USNA**

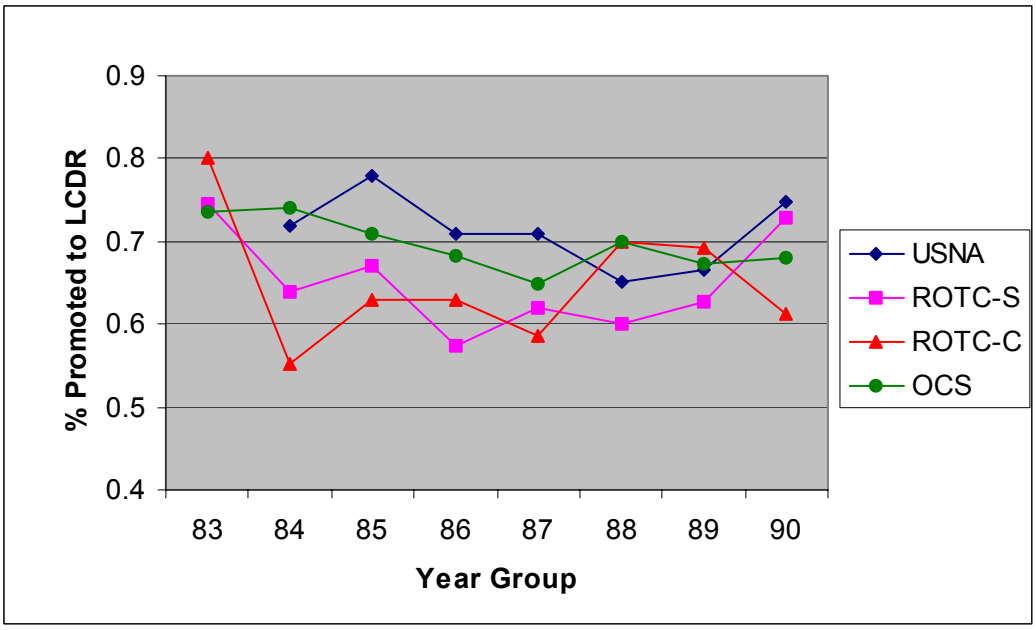

Figure 3. URL Promotion to LCDR by Accession Source.

Table 10 and Figure 4 compare URL promotion rates for the SWO, AIR, and SUB communities. Submarine officers consistently promoted at the highest rate of the communities listed in the table, yet the category SPECWO, including both Special Warfare and Special Operations Officers promoted at a mean rate of 78.1% (82 of 105 stayers), a rate slightly higher than that of the SUB community. The SWO community promoted to O-4 at the next highest rate (69.9%), while AIR experienced the lowest

promotion rate at 65.1%. The 13% point difference between SPECWO and AIR promotions is large enough to cause concern with community promotion managers; however, it is important to note that these promotion rates are calculated with the criterion "promoted at first look," corresponding to "in-zone" or "below-zone." "Above-zone" promotions were calculated as non-promotes.

Table 10. URL Promotion to LCDR by Community.

COMMUNITY	YEAR GROUP								SAMPLE MEAN
	83	84	85	86	87	88	89	90	
SWO	76.2%	69.7%	69.8%	67.8%	68.9%	69.1%	66.5%	80.7%	69.9%
SUB	80.0%	75.4%	80.8%	82.2%	77.7%	82.5%	67.3%	80.6%	77.8%
AIR	68.1%	68.1%	70.1%	62.3%	62.0%	59.8%	64.7%	68.8%	65.1%

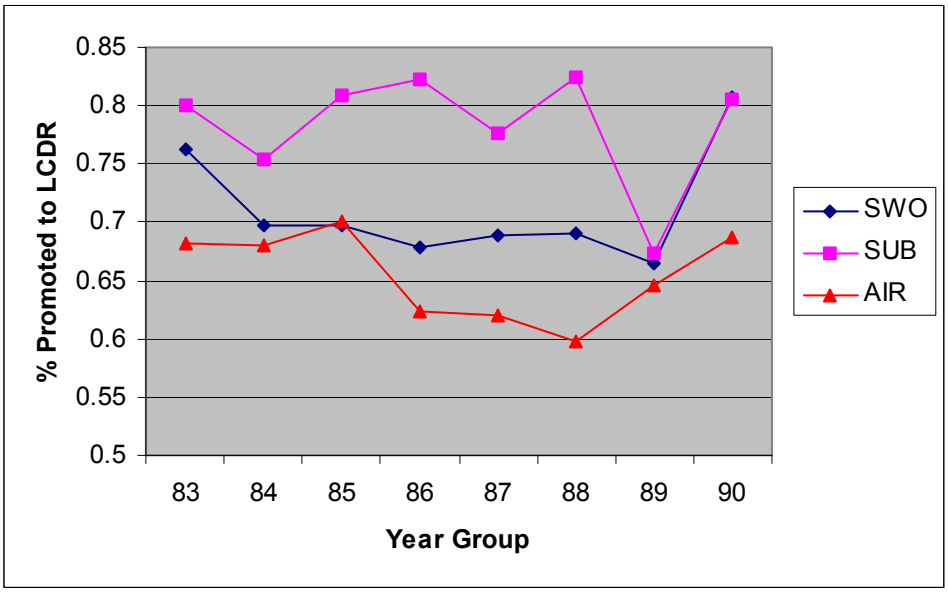

Figure 4. URL Promotion to LCDR by Community.

C. RESTRICTED LINE RETENTION AND PROMOTION RATES

Due to a significantly smaller sample size than that of the URL data sample, 5,129 observations corresponding to five accession sources and 16 different communities, Restricted Line officer retention and promotion rates were not analyzed by year group. Instead, mean retention and promotion rates were calculated in a cross tabulation. These sample mean retention and promotion rates are identified in Tables 11 and 12,

respectively. Accession source categories remain the same as URL (USNA, ROTC-S, ROTC-C, OCS, and ECP), while three community categories were created for the largest populations of officers within the Restricted Line: Fleet Support, Supply Corps, and all other Restricted Line Staff officers.

Table 11 compares the retention rates of Restricted Line officers from different accession sources and communities. ECP, OCS and ROTC-C accessions remain on active duty to the O-4 promotion board at rates nearly 15% points higher than accessions from USNA and ROTC-S. While ECP accounts for a very small fraction of the total Restricted Line sample (less than 1%), it has the highest retention rate of any of the accession sources. Conversely, in terms of overall size, OCS accesses the largest proportion of officers of any program, 57% of all Restricted Line officers, and has the second highest retention rate (55.2%).

The mission of the Naval Academy is to provide URL officers. However, 958 USNA officers appear in the RL sample. These USNA RL officers are associated with three categories: (1) officers not-physically qualified (NPQ) to service select URL designators; (2) URL warfare qualified officers that lateral transferred into RL; or (3) officers redesignated to RL after failing out of their initial training programs.

While Fleet Support and the Supply Corps communities experience nearly the same retention rate, they stay to the O-4 promotion board at a rate 10% points less than the other Restricted Line Staff officers. In terms of both accession source and community, Table 11 demonstrates that Restricted Line officers stay to the O-4 promotion board at a rate much higher than URL's.

Table 11. Restricted Line Retention by Source and Community (Year Groups 1983-1990).

CATEGORY	Total Accessed	Total Stay	Retention Rate	Std Deviation
Accession Source				
USNA	958	401	41.9%	0.366
ROTC_S	1,020	399	39.1%	0.364
ROTC_C	177	97	54.8%	0.192
OCS	2,924	1615	55.2%	0.481
ECP	50	28	56.0%	0.104
Community				
Fleet Support	1,365	627	45.9%	0.431
Supply Corps	1,980	900	45.5%	0.478
RL Staff	1,784	1013	56.8%	0.461

Table 12 compares the promotion rates of Restricted Line officers from different accession sources and communities. Similar to the retention rate analysis, ECP accessions promoted at the highest rate of any accession source (82.1%), with USNA having the second highest promotion rate (81.8%). Interestingly, USNA's retention rate was 15% points lower than OCS, yet its mean promotion rate is nearly 10% points higher than ROTC-S, ROTC-C, and OCS. Additionally, Fleet Support and Supply Corps officers promoted at a rate 7% points less than the other Restricted Line Staff officers in the sample. Table 12 also indicates that Restricted Line officers in the sample promoted to O-4 at slightly higher rates than the URL's. Restricted Line officer promotion varied from approximately 69% to 82%, while URL promotion varied from 65% to 78%.

Table 12. Restricted Line Promotion by Source and Community (Year Groups 1983-1990).

CATEGORY	Total Stay	Number Promoted	Promotion Rate	Std Deviation
Accession Source				
USNA	401	328	81.8%	0.417
ROTC_S	399	287	72.0%	0.408
ROTC_C	97	69	71.1%	0.186
OCS	1615	1147	71.0%	0.499
ECP	28	23	82.1%	0.114
Community				
Fleet Support	627	434	69.2%	0.373
Supply Corps	900	635	70.6%	0.431
RL Staff	1013	785	77.5%	0.472

D. DESCRIPTIVE STATISTICS

Tables 13 and 14 compare mean values of each of the analysis variables for the URL sample. These mean values correspond to the percent of total observations with that specific characteristic. Base case characteristics used in the logit retention and promotion models are indicated by the bold shaded variable in each category set of explanatory variables; (for example, white is the base case for the race/ethnic category. Similarly, Tables 15 and 16 compare the mean values of the analysis variables for the Restricted Line.

Table 13. Descriptive Statistics for URL Retention Sample (Sample = 17,134 Accessions).

Variable	N	Mean (Percent)	Std Dev
Stay04bd	6750	39.4%	0.488
Leave	10,384	60.6%	0.495
White	15,895	92.8%	0.588
Black	593	3.5%	0.183
Other	646	3.8%	0.19
Male	16,800	98.1%	0.622
Female	334	2.0%	0.138
SNC	9,607	56.1%	0.476
SWC	57	0.3%	0.058
MNC	269	1.6%	0.124
MWC	7201	42.0%	0.494
Prior Service	573	3.3%	0.179
No Prior Service	16,561	96.7%	0.613
Technical Major	10,512	61.4%	0.487
Non-Tech Major	6,622	38.6%	0.482
USNA	4,660	27.2%	0.418
ROTC-S	5,696	33.2%	0.471
ROTC-C	582	3.4%	0.181
OCS	6,088	35.5%	0.479
ECP	108	0.6%	0.079
NAPC1	17,134	2.037	0.989
SWO	3,467	20.2%	0.402
SUB	2,410	14.1%	0.348
AIR	11,043	64.5%	0.493
SPECWO	214	1.3%	0.111

Comparisons between Tables 13 and 14 identify notable changes in the sample characteristics between the retention sample and the promotion sample. Of those officers who decided to stay to the O-4 board, MWC increased by 4% points and SNC decreased

by 5% points from the retention sample to the promotion sample. That is, more MWC officers stayed to the O-4 career point relative to SNC officers. USNA accessions increased by 3% points and OCS accessions also decreased by 3% points from the retention sample to the promotion sample. Additionally, the SWO community increased by 5% points, while SUB decreased by 3% points and AIR decreased by 2% points from the retention to the promotion sample.

The increase in the population of SWO stayers does not seem consistent with the previous analysis of retention rates that showed SWO retention to be the lowest of any community. The difference is in the change in the number and population of officers that stayed to the O-4 board. As noted in Chapter III, the retention sample had a different composition from the promotion sample. While the number of stayers computed by comparing initial designator to O-3 designator in the retention sample identified 6,750 URL's who stayed to the O-4 board, the promotion sample is based on officers classified as URL's when they appeared at the O-4 board. So not only are the number of stayers different between samples (6,750 compared to 6,627), the composition of the populations of officers are different as well. The retention sample only accounts for officers transferring into URL communities between O-1 and O-3. The promotion sample includes all community transfers between O-1 and O-4. It is a limitation of the data files that for all officers who leave the Navy prior to the O-4 board, the designator on record is the designator at the last selection board (O-3). This accounts for the increase in SWO population percentages in the promotion sample. Due to the number of officers lateral transferring into and out of the community, SWO gained a greater number of officers (who stayed) from other communities than prior-SWO's who stayed and appeared at the O-4 board in another URL or Restricted Line community. The total net transfers in the SWO community are shown in Table 14.

Table 14. SWO Net Transfers.

SWO NET TRANSFERS (+ GAIN, - LOSS)	
Community	NUMBER
Pilot	+8
NFO	-3
Submariner	+67
Diver/EOD	-20
SEAL	-16
Fleet Support	+81
Restricted Line Other	-326
Total SWO Net Transfers	-209

Table 15. Descriptive Statistics for URL O-4 Promotion Sample (Sample = 6,727 Stayers).

Variable	N	Mean (Percent)	Std Dev
Promote	4,654	68.9%	0.463
Not promote	1,973	29.8%	0.327
White	6,160	93.0%	0.576
Black	257	3.8%	0.173
Other	210	3.1%	0.102
Male	6,512	98.3%	0.566
Female	115	1.7%	0.079
SNC	3,375	50.9%	0.433
SWC	30	0.4%	0.049
MNC	118	1.7%	0.073
MWC	3,104	46.1%	0.326
Prior Service	292	4.3%	0.122
No Prior Service	6,335	95.6%	0.519
Technical Major	4,045	59.9%	0.414
Non-Tech Major	2,582	39.0%	0.364
USNA	1,917	28.9%	0.326
ROTCS	2,207	32.7%	0.359
ROTCC	278	4.1%	0.165
OCS	2,175	32.2%	0.331
ECP	50	0.7%	0.068
NAPC1	6,627	2.127	0.956
SWO	1,680	25.4%	0.288
SUB	735	11.1%	0.163
AIR	4,107	62.0%	0.438
SPECWO	105	1.6%	0.108

Table 16. Descriptive Statistics for RL Retention Sample (Sample = 5,129 Accessions).

Variable	N	Mean (Percent)	Std Dev
Stay04bd	2,540	49.5%	0.501
Leave	2,589	50.5%	0.506
White	4,545	88.6%	0.605
Black	391	7.6%	0.265
Other	193	3.8%	0.19
Male	3,511	68.5%	0.559
Female	1,618	31.5%	0.465
SNC	2,809	54.8%	0.494
SWC	44	0.9%	0.092
MNC	431	8.4%	0.277
MWC	1,845	36.0%	0.479
Prior Service	413	8.1%	0.272
No Prior Service	4,716	91.9%	0.622
Technical Major	1,989	38.8%	0.487
Non-Tech Major	3,140	61.2%	0.556
USNA	958	18.7%	0.385
ROTCS	1,020	19.9%	0.399
ROTCC	177	3.5%	0.183
OCS	2,924	57.0%	0.495
ECP	50	1.0%	0.098
NAPC1	5,129	1.887	0.966
Fleet Support	1,365	26.6%	0.442
Supply Corps	1,980	38.6%	0.487
RL Staff Other	1,784	34.8%	0.465

Comparisons between Tables 16 and 17 identify notable changes in the sample characteristics between the retention sample and the promotion sample. The most significant change is the number of Restricted Line officers who appeared at the O-4 promotion board, as Restricted Line gained nearly 1,000 URL lateral transfers, accounting for the difference between 2,540 stayers in the retention sample compared to 3,536 stayers in the promotion sample. Of those who decided to stay to the O-4 board, 24.3% were female, compared to a 31.5% female population in the original retention sample. That is, the proportion of female officers who stayed to the O-4 board decreased relative to the proportion of females who were accessed in the RL communities. The percentage of officers classified as married with children (MWC) increased by 6% points from the retention sample to the promotion sample. The percentage of officers with a technical major increased from 38.8% in the original model to 44.8% of those officers

who stayed to the O-4 board. Additionally, OCS accessions increased by nearly six percent from the retention to the promotion sample, while USNA and ROTC-S accessions both decreased by 3% points. Another distinction in community percentages is evident as Restricted Line Staff officers increased by 5% points with respect to the Fleet Support and Supply Corps communities in the sample of officers who stayed to the O-4 promotion board.

Table 17. Descriptive Statistics for RL O-4 Promotion Sample (Sample = 3,536 Stayers).

Variable	N	Mean (Percent)	Std Dev
Promote	2,581	73.0%	0.444
Not Promoted	955	27.0%	0.438
White	3,091	87.4%	0.593
Black	294	8.3%	0.276
Other	151	4.3%	0.202
Male	2,677	75.7%	0.542
Female	859	24.3%	0.429
SNC	1,802	51.0%	0.537
SWC	36	1.0%	0.101
MNC	204	5.8%	0.233
MWC	1,494	42.3%	0.494
Prior Service	348	9.8%	0.298
No Prior Service	3,188	90.2%	0.619
Technical Major	1,585	44.8%	0.497
Non-Tech Major	1,951	55.2%	0.539
USNA	401	11.3%	0.385
ROTCS	756	21.4%	0.411
ROTCC	132	3.7%	0.189
OCS	1,932	54.6%	0.498
ECP	41	1.2%	0.107
NAPC1	3,536	1.939	0.943
Fleet Support	624	17.6%	0.381
Supply Corps	896	25.3%	0.435
RL Staff Other	2,016	57.0%	0.452

E. SUMMARY

Analysis of the retention and promotion rates for both URL and Restricted line officers, as well as the descriptive statistics in this chapter, give some preliminary indication of the relationship between the explanatory variables, most importantly accession source, and the retention and promotion outcomes. USNA accessions were more likely to stay and promote in both URL and Restricted Line communities. OCS

accessions were less likely to stay, but more likely to promote than ROTC-S accessions in URL communities. In the Restricted Line communities, OCS accessions were more likely to stay and more likely to promote than ROTC-S. ROTC-Contract officers were more likely to stay in the URL communities, but less likely to promote than the other accession sources in both the URL and Restricted Line communities. Finally, ROTC-S officers, on average, were the least likely to stay or promote in both the URL and Restricted Line communities, in particular, compared to accessions who attended the similar pre-commissioning training programs: ECP and ROTC-Contract. While these descriptive statistics are illuminating, results of multivariate analysis in Chapter V and steady state accession costs in Chapter VI will provide more insight into which commissioning programs are most cost-effective for the Navy.

V. MULTIVARIATE ANALYSIS

Multivariate modeling isolates the effect of a given explanatory variable while holding the effects of other explanatory variables constant. This thesis will use the logistic regression (logit) model to predict the probability that a binary dependent variable has a value of 1. All explanatory variables used in the logit models have been coded as a 0 or 1 as defined in Chapter III, with the exception of the single ordinal variable for undergraduate GPA (NAPC1).

A. RETENTION RESULTS FOR URL

Initial analysis of the URL and Restricted Line samples uses a basic logit model to estimate the effects of accession source on the retention of Navy officers to the O-4 promotion board. In this basic model, demographic explanatory variables and variables for technical major, NAPC1, and prior service have been included with the accession source variables. Table XXVII provides the results of this initial model for URL officers.

The computed partial effect in the 3rd column is the percentage point change in the dependent variable (STAY04BD) due to a change in an explanatory variable from 0 to 1. The partial effect for GPA reflects a one-unit increase from the mean value. This explanatory variable has an inverse relationship to the dependent variable (STAY04 BD), as a one-unit increase in the variable GPA reflects a decrease in the value of GPA by one letter grade, or approximately .4 tenths of a point. Percentage change from the base predicted probability of each model has also been computed in the 4th column of each results table. This value indicates the percentage increase or decrease in the probability an officer stays to the O-4 promotion from the baseline predicted probability. Additionally, statistically significant variables are annotated by an asterisk.

The results of model 1 indicate that URL officers from ROTC-S and OCS are less likely to stay to the O-4 board than USNA officers. The ROTC-C and OCS variables are statistically insignificant indicating no difference in retention between these two sources and USNA. Officers with technical degrees are 3.9% less likely to stay than officers who do not have technical degrees. Officers with lower GPA's are 6.7% more likely to stay than those with a mean APC. Officers with prior service are 22.5% more likely to stay

than officers with no prior enlisted service. Female URL's are 10% less likely to stay than males, and officers in the same race/ethnicity category are 20% less likely to stay than whites. As seen in previous officer retention and promotion studies (Bowman and Mehay, 2001), family status has a definite impact on the decision to stay to O-4 promotion board: SWC, MNC, and MWC all increase the probability an officer stays to the O-4 board compared to SNC (single no children); SWC (single with children) increases the probability to stay by as much as 34.3%.

Table 18. Basic Retention Model for URL Officers.

PROBABILITY OF STAYING TO O-4 FOR URL OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	% CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.1764**	.0411	-.043	-9.2%
ROTC Contract	.0577	.0906	.014	3.0%
OCS	-.3193**	.0426	-.078	-16.7%
ECP	-.3411	.2182	-.083	-17.8%
Technical Major	-.0721**	.0334	-.018	-3.9%
NAPC1 (GPA)	.1237**	.0168	.031	6.7%
Prior Service	.2763**	.1094	.105	22.5%
Black	.0315	.0867	.008	1.7%
Other	-.3814**	.0871	-.093	-20.0%
Female	-.1929*	.1196	-.048	-10.3%
SWC	.6511**	.2693	.160	34.3%
MNC	.2788**	.1279	.070	15.0%
MWC	.2761**	.0324	.069	14.8%
N	17,134			
Base Predicted Probability	.466			
Intercept	-.3872			
-2LogL	22,644.9			
Chi-Sq	331.2			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Table 19 lists the results of model 2 for URL officers. This model includes the explanatory variables from the basic model, variables for warfare community, and interaction variables that compare ROTC-S, ROTC-C, and OCS accessions who attended highly selective colleges to USNA graduates. This set of interaction variables attempts to control for differences in college quality among accession sources. The partial effects indicate that non-selective ROTC-S and ROTC-C graduates are more likely to stay than USNA, while non-selective OCS accessions are 4.4% less likely to stay than USNA. When comparing the retention of accessions that attended colleges of the same quality and selectivity, ROTC-S (RSTOP) was 25.2% less likely to stay than USNA and OCS (OCSTOP) was 13.8% less likely to stay than USNA. The net effect is that ROTC-S is 15.6% (25.2%-9.6%) less likely to stay and OCS is 9.4% (13.8%-4.4%) less likely to stay. Officers with lower GPA and prior service continued to be more likely to stay than officers with the mean APC and no prior service. Black officers were 9.6% more likely to stay than white officers, while OTHER was 17.5% less likely to stay than WHITE. Female officers were 17.9% less likely to stay than male officers. SWC, MNC, and MWC continued to be more likely to stay than SNC in model 2 as well. In terms of URL community comparisons, SPECWO was the only variable that was statistically significant, and was 16.2% more likely to stay than AIR.

B. RETENTION RESULTS FOR RESTRICTED LINE

Tables 20 and 21 provide the results of the same two retention models used in part A, but estimated for RL officers. The results in Table 20 show that ROTC-C (28.5%) and OCS (33.2%) are more likely to stay than USNA. Prior service has the greatest impact on retention to O-4 of any variable in the model: RL officers with prior service are 39.6% more likely to stay than RL officers with no prior service. Technical majors are less likely to stay than non-technical majors, and similar to the URL results, officers with lower GPA's are more likely to stay to the O-4 promotion board. Other similarities to the URL results are that SWC and MWC are more likely to stay than SNC. Quite different than the URL results, however, is that female officers in the RL sample are 27% more likely to stay than males, and Black officers are 22.6% more likely to stay than whites. Fleet Support (37.9%) and Supply Corps (34.4%) community members were less likely to stay than the other RL Staff officers in the sample.

Table 19. Retention Model 2 for URL Officers.

PROBABILITY OF STAYING TO O-4 FOR URL OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	% CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	.1765**	.0468	.044	9.6%
ROTC Contract	.2784**	.0954	.069	15.1%
OCS	-.0797*	.0454	-.020	-4.4%
ECP	-.2042	.2222	-.050	-10.9%
Technical Major	.0223	.0348	.006	1.3%
NAPC1 (GPA)	.0444**	.0181	.011	2.4%
Prior Service	.4955**	.1006	.123	26.9%
Black	.1762**	.0887	.044	9.6%
Other	-.3308**	.0882	-.080	-17.5%
Female	-.3395**	.1205	-.082	-17.9%
SWC	.6964**	.2751	.171	37.4%
MNC	.2628**	.1297	.066	14.4%
MWC	.2409**	.0330	.060	13.1%
*Source*Selectivity Interaction*				
RSTOP *(compared to USNA)*	-.4838**	.0606	-.115	-25.2%
RCTOP	-.0036	.3326	-.001	-0.2%
OCSTOP	-.2575**	.0881	-.063	-13.8%
Community (compared to Aviation)				
SWO	-.8087	.0457	-.184	-40.9%
SUB	-.7625	.0563	-.175	-38.3%
SPECWO	.2960**	.1419	.074	16.2%
N	17,134			
Base Predicted Probability	.457			
Intercept	-.2643			
-2LogL	22,102.2			
Chi-Sq	873.9			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Table 20. Retention Model 1 for RL Officers.

PROBABILITY OF STAYING TO O-4 FOR RL OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	% CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	.0393	.0988	.010	2.5%
ROTC Contract	.4696**	.1733	.116	28.5%
OCS	.5462**	.0860	.135	33.2%
ECP	.0165	.3264	.004	1.0%
Technical Major	-.2106**	.0665	-.050	-12.3%
NAPC1 (GPA)	.1138**	.0324	.028	6.9%
Prior Service	.6497**	.1242	.161	39.6%
Black	.3739**	.1140	.092	22.6%
Other	.1005	.1527	.024	5.9%
Female	.4453**	.0872	.110	27.0%
SWC	.5672*	.3368	.140	34.4%
MNC	-.1693	.1126	-.040	-9.8%
MWC	.3494**	.0645	.086	21.1%
Community (compared to Staff/Other)				
Fleet Support	-.7042**	.0947	-.154	-37.9%
Supply Corps	-.6319**	.0734	-.140	-34.4%
N	5,129			
Base Predicted Probability	.407			
Intercept	-.5932			
-2LogL	6,790.5			
Chi-Sq	319.3			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Results in Table 21 indicate ROTC-S, ROTC-C, and OCS are all more likely to stay than USNA officers. However, when comparing accessions that attended colleges of the same quality and selectivity, ROTC-S accessions (RSTOP) are 29.6% less likely to stay than USNA, and OCS accessions (OCSTOP) are 21.9% less likely to stay than USNA. Since USNA predominantly produces URL officers, a substantial portion of the USNA RL officers are prior URL's. The results of the college selectivity variables may also be attributed to the impact of either a warfare qualification or URL training on RL retention. To this end, USNA graduates are more likely to stay that selective accessions

from ROTC-S and OCS. The impact of all other explanatory variables on RL retention in the expanded model are consistent with the previous results in Table 21.

Table 21. Retention Model 2 for RL Officers.

PROBABILITY OF STAYING TO O-4 FOR RL OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	% CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	.2297**	.1099	.057	13.7%
ROTC Contract	.4759**	.1732	.118	28.4%
OCS	.5903**	.0870	.146	35.1%
ECP	.0260	.3262	.006	1.4%
Technical Major	-.2048**	.0667	-.049	-11.8%
NAPC1 (GPA)	.1167**	.0326	.029	7.0%
Prior Service	.6370**	.1243	.158	38.0%
Black	.3408**	.1141	.084	20.2%
Other	.0814	.1527	.020	4.8%
Female	.4460**	.0867	.111	26.7%
SWC	.5469*	.3370	.136	32.7%
MNC	-.1669	.1130	-.040	-9.6%
MWC	.3355**	.0647	.083	20.0%
Source *Selectivity Interaction				
RSTOP *(compared to USNA)*	-.5432	.1412	-.123	-29.6%
OCSTOP	-.3927	.1368	-.091	-21.9%
Community (compared to Staff/Other)				
Fleet Support	-.7131**	.0952	-.157	-37.7%
Supply Corps	-.6387**	.0738	-.143	-34.4%
N	5,129			
Base Predicted Probability	.416			
Intercept	-.5589			
-2LogL	6,767.1			
Chi-Sq	342.7			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Based on the literature reviewed in Chapter II, the sign and statistical significance of all the explanatory variables in Tables 18-21 seem reasonable, given the noted differences between the URL and RL communities. One notable exception is the impact of accession source in the RL communities. Unlike the results in the URL communities,

officers accessed in ROTC-S, ROTC-C and OCS are substantially more likely to stay to the O-4 promotion board than USNA accessions. USNA appears to retain URL officers at a much higher rate communities than it does RL officers. These differences may be attributed in some way to the fact that USNA predominantly produces URL officers. With the exception of the less than 2% of each graduating class accepted for post-graduate scholarship programs, officers accessed from USNA must be medically disqualified from serving in a URL community in order to service select a restricted line community. Currently, all USNA accessions service select under this criterion. Male USNA accessions represented in the data in year groups 1983 though 1990 service selected with this criterion as well. However, female USNA accessions in year groups 1983-1990 were excluded from the medical disqualification criterion and were eligible to select RL communities. Conversely, accessions from ROTC and OCS were eligible to choose either URL or RL communities. Perhaps more USNA accessions would have chosen career paths in RL communities if given the opportunity. This freedom of choice may both impact the decision to stay to the O-4 board and reduce the number of lateral transfers from URL to RL. It is important to note that USNA males account for approximately 53% of the 904 URL's in the data sample that lateral transferred to RL communities and stayed to the O-4 promotion board.

C. PROMOTION RESULTS FOR URL

A series of models were used to estimate the effects of accession source on promotion to O-4 for URL officers. Similar to the basic retention model, a basic promotion model was used on the sample of all URL officers who stayed to the O-4 board. Table 22 indicates the results of the basic promotion model estimated for the pooled sample of URL officers. ROTC-S is 8.1% less likely to stay than USNA. No other accession source variables were statistically significant in this model. Additionally, officers with technical majors were 3.1% more likely to promote to O-4 than officers who were non-technical majors. Officers with lower GPA's were 3.4% less likely to promote than officers with the mean GPA. Officers in the other race/ethnicity category were 7.3% less likely to promote than whites. Officers in the MWC family status category were 3% more likely to promote to O-4 than officers in the SNC category. Due to the lack of statistically significant accession source variables and the hypothesis that we should

expect to observe promotion differences within each URL community, separate promotion models were estimated for each URL community.

D. PROMOTION RESULTS FOR SWO

Table 23 indicates the promotion results for Surface Warfare Officers. ROTC-S and OCS were less likely to promote to O-4 than USNA. In terms of undergraduate academic experience, having a technical major increases the probability of promoting by 3.3%, and having a lower GPA decreases the probability of promoting by 4.3%. The race/ethnicity variable OTHER is the only demographic variable in the model that is statistically significant. Officers in the other race/ethnicity category are 8.6% less likely to promote than white officers who stayed to the O-4 board.

The results in Table 24 for SWO's indicate ROTC-S and OCS are less likely to promote than USNA, yet RSTOP (6.2%) and OCSTOP (10.8%) are more likely to promote than USNA graduates. This signifies a substantial difference in the promotion probabilities of accessions from the same source that attend different quality colleges and universities. ROTC-S and OCS as a whole are not as competitive as USNA, yet individuals accessed through those programs who attended elite colleges and universities promote at a higher rate than USNA graduates. This reemphasizes the impact and economic return to attending elite, public and private universities. (Bowman and Mehay, 2002)

Table 22. Basic Promotion Model for URL Officers.

PROBABILITY OF PROMOTING TO O-4 URL OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.2924**	.0683	-.060	-8.1%
ROTC Contract	-.1670	.1399	-.033	-4.4%
OCS	-.0414	.0727	-.008	-1.1%
ECP	.6293	.3998	.102	13.7%
Technical Major	.1239**	.0560	.023	3.1%
NAPC1 (GPA)	-.1290**	.0288	-.025	-3.4%
Prior Service	-.1331	.1470	-.026	-3.5%
Black	-.0370	.1385	-.007	-0.9%
Other	-.2632*	.1484	-.054	7.3%
Female	.1610	.2134	.030	4.0%
SWC	-.4929	.3758	-.105	-14.2%
MNC	.3003	.2171	.053	7.1%
MWC	.1167**	.0560	.022	3.0%
N	6,750			
Base Predicted Probability	.742			
Intercept	1.329			
-2LogL	8,263.9			
Chi-Sq	99.5			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Table 23. Basic Promotion Model for SWO Officers.

PROBABILITY OF PROMOTING TO O-4 FOR SURFACE WARFARE OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	% CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.4600**	.1385	-.075	-9.0%
ROTC Contract	.0548	.2542	-.008	-1.0%
OCS	-.3199*	.1645	-.050	-6.0%
Technical Major	.2012*	.1132	.027	3.3%
NAPC1 (GPA)	-.2342**	.0634	-.036	-4.3%
Prior Service	-.1214	.2600	-.018	-2.2%
Black	-.2681	.1861	-.041	-4.9%
Other	-.4403*	.2401	-.071	-8.6%
Female	.2932	.4764	.038	4.6%
MNC	.5505	.4659	.064	7.7%
MWC	.1694	.1144	.022	2.7%
N	1,680			
Base Predicted Probability	.830			
Intercept	2.134			
-2LogL	1,976.4			
Chi-Sq	55.4			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Table 24. Promotion Model for SWO Officers (with Interaction Variables).

PROBABILITY OF PROMOTING TO O-4 FOR SURFACE WARFARE OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.5244**	.1456	-.088	-10.7%
ROTC Contract	.0477	.2588	.007	0.8%
OCS	-.3509**	.1707	-.056	-6.8%
Technical Major	.1902*	.1138	.026	3.1%
NAPC1 (GPA)	-.2242**	.0637	-.035	-4.2%
Prior Service	-.2441	.2709	-.038	-4.6%
Black	-.2729	.1876	-.043	-5.2%
Other	-.4044*	.2405	-.066	-8.0%
Female	.2257	.4796	.030	3.6%
MNC	.5355	.4679	.064	7.7%
MWC	.1704	.1150	.023	2.8%
*Source*Selectivity Interaction*				
RSTOP *(compared to USNA)*	.4052*	.2168	.051	6.2%
OCSTOP	.8204*	.4355	.089	10.8%
N	1,680			
Base Predicted Probability	.826			
Intercept	2.087			
-2LogL	2,031.8			
Chi-Sq	69.3			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

After adding the lateral transfer variables LAT_TO_SWO and SWO_2_URLO to the SWO promotion model in Table 25 there are notable changes in the partial effects of the demographic variables BLACK and MWC. BLACK becomes statistically significant and indicates BLACKS are 4.9% less likely to promote to O-4. MWC also becomes statistically significant in this model and shows that officers who are married with children are 4.3% more likely to promote than SNC. ROTC-S and OCS remain less likely to promote than USNA, while RSTOP is still more likely to promote than USNA. The LAT_TO_SWO variable is statistically significant and accounts for officers who appeared at the O-4 board in the SWO community after starting their career in a different

URL or RL community. These officers are 4.5% less likely to promote to O-4 than SWO's who began their career and remained in the SWO community.

These results support the value of the initial Division Officer sea tours and increased years of experience in a community prior to selection for O-4. SWO officers average nearly 6.5 years "at-sea," OJT (on-the-job-training) prior to the O-4 promotion point. Nearly all shiphandling proficiency and battle-group operations experience occur during the division officer and department head sea tours. High levels of performance in these areas remain critical to SWO fitness report rankings. Unlike the level of training that occurs in flight school, nuclear power school, and BUDS (Basic Underwater Demolitions School), SWO proficiency occurs more in the fleet than in the training pipeline. Shiphandling and TAO (Tactical Action Officer) training have been simulated in various SWOS courses in Newport, Rhode Island. However, simulated training is no replacement for real ship-based operations. In contrast, Aviation officers spend approximately two years flying various aircraft before they report to their initial squadrons. Submarine officers spend in excess of two years in nuclear power school and prototype school operating nuclear reactors before they report to their first submarines. Officers that lateral transfer into those communities get the same level of experience because every officer attends the same pipeline training. Additionally, success in the initial tours can be generalized as follows. Aviators need to be expert pilots and equipment operators; these skills can be acquired in the training pipeline. Submariners require expert knowledge of nuclear power and submarine-based engineering configurations; these skills also can be learned in the training pipeline. SWO's need to be good shiphandlers and have critical understanding of engineering, damage control, and tactical operations; these skills are attained in the fleet, not in the training pipeline. To this end, it is hypothesized that lateral transfers into the Aviation and Submarine communities will be as likely or even more likely to promote to O-4 than officers who start in those two communities, while officers that lateral transfer into the Surface community miss out on valuable fleet experiences and are less likely to promote to O-4.

Table 25. Promotion Model for SWO Officers (with Lateral Transfer Variables).

PROBABILITY OF PROMOTING TO O-4 FOR SURFACE WARFARE OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.4875**	.1264	-.082	-10.0%
ROTC Contract	-.0291	.2189	-.004	-0.5%
OCS	-.4725**	.1528	-.079	-9.6%
Technical Major	.2001**	.0947	.027	3.3%
NAPC1 (GPA)	-.2459**	.0527	-.039	-4.7%
Prior Service	.0571	.2195	.008	1.0%
Black	-.2567*	.1596	-.040	-4.9%
Other	-.3311	.1963	-.053	-6.4%
Female	.2987	.3531	.039	4.7%
MNC	.3040	.3537	.040	4.9%
MWC	.2644**	.0952	.035	4.3%
*Source*Selectivity Interaction*				
RSTOP *(compared to USNA)*	.3693**	.1753	.048	5.8%
OCSTOP	.1822	.3071	.025	3.0%
Lateral Transfer				
LAT_TO_SWO	-.2337**	.1105	-.037	-4.5%
SWO_2_URLO	.0163	.1906	.002	0.2%
N	2,542			
Base Predicted Probability	.823			
Intercept	2.108			
-2LogL	2,874.1			
Chi-Sq	70.2			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

E. PROMOTION RESULTS FOR AVIATION

The results in Tables 26 and 27 indicate that the partial effects of ROTC-S for Aviation officers are consistent with those of the SWO community. Table 26 shows that ROTC-S and ROTC-C are both less likely to promote to O-4 than USNA. MWC also remains 3.3% more likely to promote than SNC. Table 27 includes the college selectivity interaction variables with the basic promotion model. ROTC-S is the only statistically significant variable; ROTC-S is 4.6% less likely to promote to O-4 than USNA.

The results in Table 28 indicate that adding the lateral transfer variables to the second promotion model impact the partial effects of the other explanatory variables for accession source, technical major, and GPA. ROTC-S remains less likely to promote than USNA, but ROTC-C is 1.4% more likely to promote than USNA in this model. Officers with technical majors are 3.3% more likely to promote to O-4 than officers with non-technical majors. As hypothesized in Chapter II, officers with lower GPA's were 2.9% less likely to promote to O-4. Finally, unlike the results for the SWO community, LAT_TO_AIR is 10.2% more likely to promote to O-4 than officers who began their careers in aviation.

These results support the previous hypothesis in Part D about pipeline training and reemphasize the value of earning a URL warfare qualification prior to lateral transferring to pilot or NFO designators. The increase in the probability of promotion for these lateral transfers also disproves the belief that having fewer tours in aviation billets and fewer career flight-hours makes an officer less likely to promote.

Table 26. Basic Promotion Model for Aviation Officers.

PROBABILITY OF PROMOTING TO O-4 FOR AVIATION OFFICERS; PILOT & NFO (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.2012**	.0859	-.044	-6.3%
ROTC Contract	-.2963*	.1799	-.065	-9.2%
OCS	.1368	.0899	.028	4.0%
Technical Major	.0975	.0696	.020	2.8%
NAPC1 (GPA)	-.0606	.0387	-.013	-1.8%
Prior Service	-.0822	.1940	-.017	-2.4%
Black	.3532	.2459	.068	9.7%
Other	-.1612	.2049	-.035	-5.0%
Female	.1555	.2439	.031	4.4%
MNC	.2730	.2736	.054	7.7%
MWC	.1134*	.0681	.023	3.3%
N	4,107			
Base Predicted Probability	.703			
Intercept	.9937			
-2LogL	5,205.2			
Chi-Sq	58.4			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Table 27. Promotion Model for Aviation Officers (with Interaction Variables)

PROBABILITY OF PROMOTING TO O-4 FOR AVIATION OFFICERS; PILOT & NFO (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.1508*	.0933	-.032	-4.6%
ROTC Contract	-.2919	.1866	-.064	-9.1%
OCS	.1446	.0925	.029	4.1%
Technical Major	.1047	.0700	.021	3.0%
NAPC1 (GPA)	-.0589	.0388	-.012	-1.7%
Prior Service	-.1553	.2103	-.033	-4.7%
Black	.3522	.2464	.068	9.7%
Other	-.1727	.2051	-.037	-5.3%
Female	.1626	.2443	.033	4.7%
MNC	.2569	.2739	.051	7.3%
MWC	.1089	.0683	.022	3.1%
Source*Selectivity Interaction				
RSTOP *(compared to USNA)*	-.1627	.1259	-.035	-5.0%
OCSTOP	.0366	.2148	.008	1.1%
N	4,107			
Base Predicted Probability	.704			
Intercept	.9888			
-2LogL	5,202.7			
Chi-Sq	60.9			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Table 28. Promotion Model for Aviation Officers (with Lateral Transfer Variables).

PROBABILITY OF PROMOTING TO O-4 FOR AVIATION OFFICERS; PILOT & NFO (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.2019**	.0901	-.044	-6.3%
ROTC Contract	-.3236**	.1699	.010	1.4%
OCS	.0823	.0889	.017	2.4%
Technical Major	.1115*	.0673	.023	3.3%
NAPC1 (GPA)	-.0948**	.0373	-.020	-2.9%
Prior Service	.0294	.1895	.006	0.9%
Black	.2449	.2211	.049	7.0%
Other	-.3024	.1896	-.067	-9.6%
Female	.2316	.2333	.046	6.6%
MNC	.1992	.2575	.040	5.7%
MWC	.1212*	.0657	.025	3.6%
Source*Selectivity Interaction				
RSTOP *(compared to USNA)*	-.1889	.1214	-.041	-5.9%
OCSTOP	.0483	.2082	.010	1.4%
Lateral Transfer				
LAT_TO_AIR	.3670*	.2058	.071	10.2%
AIR_2_URLO	.1865	.1365	.038	5.4%
N	4,429			
Base Predicted Probability	.698			
Intercept	1.047			
-2LogL	5,599.0			
Chi-Sq	67.5			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

F. PROMOTION RESULTS FOR SUBMARINE

Results of the basic promotion model for submarine officers in the data sample are shown in Table 29. It is important to note that no ROTC-C officers or females were contained in the sample of submarine officers who stayed to the O-4 promotion board. Therefore, no inferences about the relationship or impact of these variables on promotion in the submarine community can be drawn. Despite this limitation, Table 29 indicates that OCS officers are 6.6% less likely to promote to O-4 than USNA. Similar to the results for Aviation officers, a lower GPA is associated with a decrease in the probability of promotion. The race variable BLACK is statistically significant and has the largest impact of any explanatory variables in the model on the probability of promotion; BLACK is 25.4% less likely to promote than WHITE. However, this result is questionable as there are only eight observations in the sample.

Despite including the college quality interaction variables in the second promotion model, the results in Table 30 are consistent with the results of the basic promotion model. When the lateral transfer variables are included in Table 31, GPA and LAT_TO_SUB are the only explanatory variables that are statistically significant. A lower GPA decreases the probability of promoting to O-4 by 5.4%, while LAT_TO_SUB is 10.1% more likely to promote to O-4 than officers directly accessed into the submarine community. Similar to the results Aviation officers, the 193 officers that lateral transferred into the submarine community promoted to O-4 at a higher rate than the other submarine officers that stayed to the O-4 board. These results are consistent with the hypothesis developed in PART D about the value of nuclear power school and prototype school for lateral transfers.

Table 29. Basic Model for Submarine Officers.

PROBABILITY OF PROMOTING TO O-4 FOR SUBMARINE OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.1182	.2415	-.014	-1.6%
OCS	-.4423*	.2354	-.058	-6.6%
Technical Major	-.1736	.3640	-.021	-2.4%
NAPC1 (GPA)	-.2260**	.1144	-.027	-3.1%
Prior Service	-.0861	.4438	-.010	-1.1%
Black	-1.3036*	.7409	-.222	-25.4%
Other	-.6886	.6200	-.097	-11.1%
MNC	.0873	.6916	.009	1.0%
MWC	-.0549	.1894	-.006	-0.7%
N	735			
Base Predicted Probability	.873			
Intercept	2.1857			
-2LogL	743.2			
Chi-Sq	24.4			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Table 30. Promotion Model for Submarine Officers (with Interaction Variables).

PROBABILITY OF PROMOTING TO O-4 FOR SUBMARINE OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.1624	.2863	-.012	-1.4%
OCS	-.5011**	.2494	-.065	-7.4%
Technical Major	-.2045	.3718	-.024	-2.7%
NAPC1 (GPA)	-.2360**	.1156	-.028	-3.2%
Prior Service	-.1508	.5633	-.017	-1.9%
Black	-1.2932*	.7447	-.216	-24.7%
Other	-.7319	.6235	-.103	-11.8%
MNC	.1067	.6943	.011	1.3%
MWC	-.0508	.1898	-.006	-0.7%
Source*Selectivity Interaction				
RSTOP *(compared to USNA)*	.1164	.3733	.012	1.4%
OCSTOP	.3707	.4107	.035	4.0%
N	735			
Base Predicted Probability	.876			
Intercept	2.228			
-2LogL	742.2			
Chi-Sq	25.4			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Table 31. Promotion Model for Submarine Officers (with Lateral Transfer Variables).

PROBABILITY OF PROMOTING TO O-4 FOR SUBMARINE OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	.0261	.2638	.005	0.7%
OCS	-.2760	.2400	-.056	-7.5%
Technical Major	-.0677	.2810	-.013	-1.7%
NAPC1 (GPA)	-.2016**	.0989	-.040	-5.4%
Prior Service	.0145	.3893	.003	0.4%
Black	-.7134	.5260	-.157	-21.1%
Other	-.5573	.4759	-.119	-16.0%
MNC	.4220	.6711	.072	9.7%
MWC	.0199	.1640	.004	0.5%
Source*Selectivity Interaction				
RSTOP *(compared to USNA)*	.1940	.3283	.035	4.7%
OCSTOP	.4633	.3797	.078	10.5%
Lateral Transfer				
LAT_TO_SUB	.4411*	.2695	.075	10.1%
SUB_2_URLO	.3091	.2150	.054	7.3%
N	963			
Base Predicted Probability	.743			
Intercept	1.477			
-2LogL	973.7			
Chi-Sq	23.5			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

G. PROMOTION RESULTS FOR RESTRICTED LINE

The results in Table 32 for RL Officers support the previous interpretation of the impact of accession source on promotion from the preliminary analysis of promotion rates in Chapter IV. ROTC-S, ROTC-C, and OCS are all less likely to promote to O-4 than USNA. Table 32 also indicates prior service is statistically significant for the first time in any of the promotion models; RL officers with prior service are 5.9% more likely to promote to O-4 than officers with no prior service. The effect of a lower GPA in this model is consistent with the URL promotion models. Additionally, Table 32 compares the probability of promotion for each of the three RL categories. Fleet Support officers are 7.8% less likely to promote than RL Staff officers, and Supply Corps officers are 4% less likely to promote than RL Staff officers

Table 33 includes both the college selectivity interaction variables and the variable URL_LATS, corresponding to prior URL officers that lateral transferred into the RL community after O-3 selection. The impacts of accession source, GPA, prior service, and community are consistent with the previous model. Additionally, the impact of URL_LATS is positive and statistically significant. Similar to the URL communities, it reemphasizes the value of a URL warfare qualification in the RL communities. The 904 URL lateral transfers into RL communities are 11.4% more likely to promote to O-4 than officers that spent their careers in RL communities.

Table 32. Basic Promotion Model for RL Officers.

PROBABILITY OF PROMOTING TO O-4 FOR RESTRICTED LINE OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.4329**	.1296	-.078	-9.7%
ROTC Contract	-.4197*	.2222	-.075	-9.3%
OCS	-.6018**	.1188	-.112	-14.0%
ECP	.0121	.4557	.002	0.2%
Technical Major	-.0847	.0867	-.014	-1.7%
NAPC1 (GPA)	-.1547**	.0435	-.026	-3.2%
Prior Service	.3287**	.1470	.047	5.9%
Black	-.0987	.1404	-.016	-2.0%
Other	-.2420	.1812	-.041	-5.1%
Female	.0777	.1494	.012	1.5%
SWC	-.4606	.3556	-.083	-10.3%
MNC	.0278	.1753	.004	0.5%
MWC	.0431	.0845	.007	0.9%
Community (compared to Staff/Other)				
Fleet Support	-.3607**	.1621	-.063	-7.8%
Supply Corps	-.1892*	.0992	-.032	-4.0%
N	3,536			
Base Predicted Probability	.803			
Intercept	1.703			
-2LogL	4,046.8			
Chi-Sq	78.6			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

Table 33. Promotion Model for RL Officers (with Interaction and Lateral Transfer Variables).

PROBABILITY OF PROMOTING TO O-4 FOR RESTRICTED LINE OFFICERS (YR GROUPS 1983-1990)				
VARIABLE	PARAMETER ESTIMATE	STD ERROR	PARTIAL EFFECT (% PT CHANGE)	%CHANGE FROM BASE
Accession Source (compared to USNA)				
ROTC Scholarship	-.3880**	.1404	-.068	-8.5%
ROTC Contract	-.4189*	.2222	-.074	-9.2%
OCS	-.5890**	.1204	-.109	-13.6%
ECP	.0175	.4558	.003	0.4%
Technical Major	-.0834	.0867	-.013	-1.6%
NAPC1 (GPA)	-.1528**	.0436	-.025	-3.1%
Prior Service	.3244**	.1473	.046	5.7%
Black	-.1053	.1405	-.017	-2.1%
Other	-.2486	.1813	-.042	-5.2%
Female	.0813	.1496	.012	1.5%
SWC	-.4696	.3557	-.084	-10.4%
MNC	.0280	.1754	.004	0.5%
MWC	.0379	.0847	.006	0.7%
Community (compared to Staff/Other)				
Fleet Support	-.3667**	.1625	-.064	-8.0%
Supply Corps	-.1933*	.0994	-.032	-4.0%
Source*Selectivity Interaction				
RSTOP *(compared to USNA)*	-.1499	.1792	-.025	-3.1%
OCSTOP	-.1080	.1204	-.018	-2.2%
Lateral Transfer				
URL_LATS	.5266**	.1253	.092	11.4%
N	3,536			
Base Predicted Probability	.804			
Intercept	1.710			
-2LogL	4,045.8			
Chi-Sq	79.6			

Asterisks denote levels of statistical significance.
* = significant at the 90% level; ** = significant at the 95% level.

VI. URL COST ANALYSIS

Bowman (1995) concludes that in order to maintain a given endstrength and force structure of high quality officers in a steady state environment, it is necessary to assess the requirement for these officers and differences in individual retention and promotion rates. He further distinguishes between technical and economic efficiency. Results of the preliminary analysis of retention and promotion rates in Chapter IV and the multivariate analyses in Chapter V indicate USNA is the most technically efficient accession source in retaining and promoting officers to O-4 in URL and RL communities. Despite being technically efficient in producing O-4's, USNA may not be the most economically efficient of the accession sources due its high pre-commissioning education costs. The methodology for analyzing costs in this chapter is based on Bowman's (1995) methodology, and relies on computing a "steady state flow" of accessions for each commissioning accession source and community.

The steady state flow of accession is determined from a simple mathematical calculation that accounts for retention and promotion rate differentials. The equation for the steady state number of accessions is:

$$\textit{Steady State Number of Accessions} = \frac{1}{\textit{(Retention Rate x Promotion Rate to O-4)}}$$

The steady state number of accessions corresponds to the number of accessions required to retain and promote one officer to LCDR. The cost of producing one LCDR from each commissioning source is then obtained by multiplying the steady state number of accessions by the total pre-and post-commissioning training costs. In this thesis, two different models have been developed to demonstrate the difference between average and marginal pre-commissioning costs. Average pre-commissioning costs were obtained from Bowman (1995). Bowman's (1995) findings were reproduced in Table 1, Chapter II. Marginal pre-commissioning costs were obtained from Parcell (2001).

The pre-commissioning costs calculated in Table 39 are notably different from Bowman's (1995) listed in Table 1. Bowman (1995) applied a 10% discount rate to 1994 cost figures obtained from the Office of the Comptroller, The United States Naval Academy and the Chief of Naval Education and Training (CNET). Pre-commissioning costs listed in Table 39 have been discounted at a rate of 7%, vice 10%, and inflated at a rate of 18.4% to convert dollar figures to 2002 dollars.

Estimated post-commissioning costs from YCS1 to YCS10 have been calculated using direct and indirect costs associated with lifecycle education and training in the URL warfare communities. Direct costs represent the cost of providing human capital investment, while indirect (opportunity) costs reflect the cost to the Navy of an officer's forgone time while serving in an education/training billet or during the time spent acquiring a warfare qualification (Bowman, 1995). The total of direct and indirect costs for each warfare community are listed in Tables 34-37 in the column labeled "TRNG COSTS." These costs were obtained from Bowman (1995) and are measured in 1994 dollars. Bowman (1995) based these estimates on the typical career patterns of officers in each URL community. Since no post-commissioning cost data for Restricted Line officers was available for this analysis, this chapter analyzes only URL steady state cost-effectiveness.

A. URL COST EFFECTIVENESS USING AVERAGE PRE-COMMISSIONING COSTS

Tables 34-37 also indicate the actual and present value of the post-commissioning costs associated with each community and commissioning source. Costs listed in the column "ACTUAL VALUES" account for differences in education and training costs during the career period O1-O3 (YCS1-YCS4) and O3-O4 (YCS5-YCS10). Actual costs were calculated by multiplying the retention rate indicated in the column "% STAY TO LAST YEAR" by the costs listed in the column "TRNG COSTS." "ACTUAL VALUES" were further discounted at a rate of 7% to produce the present value of total post-commissioning costs incurred by the Navy to the O-4 career point.

Table 38 identifies the total steady state costs necessary to produce one O-4 from each accession source by URL community. These steady state lifecycle costs are comprised of average pre-commissioning costs (column 1) and post-commissioning costs

(column 2). The sum of these costs is listed in column 3. The steady state number of accessions required to produce one O-4 are listed in column 4. The total present value costs from Tables 34-37 were inflated at a rate of 18.4% to express costs in 2002 dollars. These costs are the post-commissioning costs listed in Tables 38 and 40. Additionally, multiplying required accessions in column 4 by total costs in column 3 yield the "COSTS PER O-4" in column 5.

The results in Table 38 are summarized in Table 39, which indicates that no single accession source has a monopoly on cost-effectiveness across the four URL communities. In the Surface community, ROTC-Contract is the most cost-effective source while USNA is the least cost-effective. It is important to note that USNA has the lowest required number of accessions to produce a single O-4 in three of the four URL communities, and is ranked second in the Surface community. Despite the fact that USNA graduates stay and promote at higher rates than the other accession sources, the differences are not sufficient to overcome the higher average pre-commissioning cost for USNA graduates.

The results in Tables 38 and 39 indicate that steady state flow costs by commissioning source in the Submarine community are consistent with the Surface community. ROTC-Contract remains the most cost-effective source, followed closely by OCS, then ROTC-Scholarship, and USNA. In the Pilot community, USNA becomes the most cost-effective program due to the combined effect of a lower steady state number of accessions and higher post-commissioning costs relative to pre-commissioning costs. ROTC-Scholarship is second in terms of cost-effectiveness, while OCS is least cost-effective at producing O-4 pilots. Analysis of NFO steady state costs reveal significantly different accession source rankings than in the pilot community. USNA is most cost-effective at producing O-4 NFO's, while ROTC-Contract is second, OCS is third, and ROTC Scholarship is least cost-effective.

B. COST-EFFECTIVENESS ANALYSIS OF COMMISSIONING SOURCES USING MARGINAL COSTS

In a recent 2001 study by the Center for Naval Analyses, Parcell (2001) determines marginal costs associated with making incremental increases in the size of the USNA Brigade of Midshipmen. The CNA study approaches the topic of cost-

effectiveness from the standpoint of analyzing marginal increases of 100 or more accessions per year from USNA versus OCS. The basis for marginal cost comparisons is whether or not an accession source is currently operating at full capacity. Parcell (2001) notes that USNA's current size of 4,000 is less than its design capacity of 4,400. Due to this excess capacity, USNA could absorb an increase of 100 accessions at a cost far less than those indicated by the average cost numbers in Table 38. NROTC and OCS on the other hand are assumed to be currently operating at full capacity. Therefore, increases in the size of these programs would result in substantially greater costs than those listed in Table 38.

In an effort to analyze the impact of using marginal pre-commissioning costs, Table 40 substitutes the marginal costs generated by the CNA study for average costs. The cost-effectiveness results are summarized in Table 41. In comparison to the results in Tables 38 and 39, USNA is no longer the least cost-effective accession source in the SWO community; USNA is now competitive with the other accession sources. ROTC-Contract remains the most cost-effective, while ROTC-Scholarship is the least cost-effective by more than $460,000. Results in the Submarine community are substantially different in Tables 40 and 41 as well. USNA is the most cost-effective, followed by OCS, ROTC-Contract, and ROTC-Scholarship.

In the Pilot community, USNA remains the most cost-effective by more than $500,000. ROTC-Scholarship is second, and ROTC-Contract is third. OCS is the least cost-effective accession source in the Pilot community, just as it was in Tables 38 and 39. Analysis of the NFO community reveals similar results to those indicated in Table 38. USNA is the most cost-effective accession source, yet the cost differential between USNA and ROTC-Contract (second) increases from $52,000 in Table 38 to over $440,000 in Table 40. OCS remains in third position in this model, with ROTC-Scholarship as the least cost-effective at producing NFO's.

C. SUMMARY

The costs analysis in this chapter provides a framework for assessing each commissioning program in a steady state environment. The results of Tables 38 and 40 indicate that the use of marginal pre-commissioning costs relative to average costs can

impact both the steady state cost per O-4 and the relative efficiency of each commissioning source. Using marginal costs for pre-commissioning costs seems to make USNA as competitive and cost-effective in the Surface and Submarine communities as it is in the Aviation community when average cost is used. While no single accession source is always the most cost-effective or least cost-effective in all four communities, ROTC-Scholarship fares much worse in the marginal cost model. Additionally, the steady state cost analysis supports the theory that accessions from ROTC-Contract not only promote to O-4 at different rates than ROTC- Scholarship accessions, but they cost less in all URL communities except the Pilot community.

Currently, the demand for experienced and more senior URL officers is expected to grow. (Parcell, 2001) In order to make trade-off decisions and incremental increases in accessions in response to this demand, the Navy's leadership needs to know if one accession source is producing a specific community of officers at a rate less costly than another accession source. The results of Tables 38-41 support USNA as the premier commissioning program for these increased accessions. While the Navy does not access many officers from the ROTC-Contract program, the results in this chapter may signal a need to recruit more of these officers to fill personnel shortages that cannot be met by the ROTC-Scholarship program, and would otherwise require additional OCS accessions.

Table 34. Estimated Post-Commissioning Education and Training Costs for SWO's (1994 Dollars).

SOURCE YEARS OF SERVICE	TOTAL COSTS ADJUSTED FOR SEPARATIONS PRIOR TO O-4			
	SURFACE			
	% STAY TO LAST YEAR	TRNG COSTS	ACTUAL VALUE	PRESENT VALUE
USNA				
1-4:	1.00	51,093	51,093	41,707
5-10:	0.31	108,352	33,924	25,881
TOTAL		159,445	85,017	67,588
ROTCS				
1-4:	1.00	51,093	51,093	41,707
5-10:	0.22	108,352	23,516	17,940
TOTAL		159,445	74,609	59,647
ROTCC				
1-4:	1.00	51,093	51,093	41,707
5-10:	0.34	108,352	108,352	28,243
TOTAL		159,445	159,445	69,950
OCS				
1-4:	1.00	51,093	51,093	41,707
5-10:	0.31	108,352	33,104	25,255
TOTAL		159,445	84,197	66,962

Table 35. Estimated Post-Commissioning Education and Training Costs for Submariners (1994 Dollars).

SOURCE YEARS OF SERVICE	TOTAL COSTS ADJUSTED FOR SEPARATIONS PRIOR TO O-4			
	SUBMARINE			
	% STAY TO LAST YEAR	TRNG COSTS	ACTUAL VALUE	PRESENT VALUE
USNA				
1-4:	1.00	117,837	117,837	96,190
5-10:	0.31	64,200	19,633	14,978
TOTAL		182,037	137,470	111,168
ROTCS				
1-4:	1.00	117,837	117,837	96,190
5-10:	0.27	64,200	17,502	13,352
TOTAL		182,037	135,339	109,543
ROTCC				
1-4:	1.00	117,837	117,837	96,190
5-10:	0.30	64,200	19,260	14,693
TOTAL		182,037	137,097	110,883
OCS				
1-4:	1.00	117,837	117,837	96,190
5-10:	0.23	64,200	14,804	11,294
TOTAL		182,037	132,641	107,484

Table 36. Estimated Post-Commissioning Education and Training Costs for Pilots (1994 Dollars).

SOURCE YEARS OF SERVICE	TOTAL COSTS ADJUSTED FOR SEPARATIONS PRIOR TO O-4			
	PILOT			
	% STAY TO LAST YEAR	TRNG COSTS	ACTUAL VALUE	PRESENT VALUE
USNA				
1-4:	1.00	1,319,100	1,319,100	1,076,779
5-10:	0.63	24,534	15,522	11,842
TOTAL		1,343,634	1,334,622	1,088,620
ROTCS				
1-4:	1.00	1,319,100	1,319,100	1,076,779
5-10:	0.61	24,534	14,917	11,380
TOTAL		1,343,634	1,334,017	1,088,159
ROTCC				
1-4:	1.00	1,319,100	1,319,100	1,076,779
5-10:	0.56	24,534	13,731	10,475
TOTAL		1,343,634	1,332,831	1,087,254
OCS				
1-4:	1.00	1,319,100	1,319,100	1,076,779
5-10:	0.41	24,534	10,042	7,661
TOTAL		1,343,634	1,329,142	1,084,439

Table 37. Estimated Post-Commissioning Education and Training Costs for NFO's (1994 Dollars).

SOURCE YEARS OF SERVICE	TOTAL COSTS ADJUSTED FOR SEPARATIONS PRIOR TO O-4			
	NFO			
	% STAY TO LAST YEAR	TRNG COSTS	ACTUAL VALUE	PRESENT VALUE
USNA				
1-4:	1.00	1,477,000	1,477,000	1,205,672
5-10:	0.58	24,534	14,148	10,794
TOTAL		1,501,534	1,491,148	1,216,466
ROTCS				
1-4:	1.00	1,477,000	1,477,000	1,205,672
5-10:	0.55	24,534	13,551	10,338
TOTAL		1,501,534	1,490,551	1,216,010
ROTCC				
1-4:	1.00	1,477,000	1,477,000	1,205,672
5-10:	0.53	24,534	13,085	9,982
TOTAL		1,501,534	1,490,085	1,215,654
OCS				
1-4:	1.00	1,477,000	1,477,000	1,205,672
5-10:	0.50	24,534	12,249	9,345
TOTAL		1,501,534	1,489,249	1,215,017

Table 38. URL Costs Per O-4 Using Average Pre-Commissioning Costs.

AVERAGE PRE-AND POST-COMMISSIONING COSTS REQUIRED TO MAINTAIN STEADY STATE FLOW BY COMMUNITY AND SOURCE (IN 2002 DOLLARS).

Accession Source	Discounted Costs			Number of Accessions	Costs Per O-4
	Pre-Commissioning	Post-Commissioning	Total		
SURFACE:					
USNA	229,227	80,044	309,271	4.47	1,382,442
ROTC Scholarship	93,653	70,640	164,293	7.20	1,182,911
ROTC Contract	53,620	82,841	136,461	4.29	585,416
OCS	43,880	79,302	123,182	6.36	783,435
SUBMARINE:					
USNA	229,227	131,656	360,883	4.10	1,479,621
ROTC Scholarship	93,653	129,731	223,384	5.10	1,139,260
ROTC Contract	53,620	131,319	184,939	5.00	924,693
OCS	43,880	127,293	171,173	5.72	979,107
PILOT:					
USNA	229,227	1,289,253	1,518,480	2.31	3,507,689
ROTC Scholarship	93,653	1,288,707	1,382,360	2.66	3,677,078
ROTC Contract	53,620	1,287,635	1,341,255	3.20	4,292,014
OCS	34,813	1,284,301	1,319,114	3.49	4,603,709
NFO:					
USNA	229,227	1,440,660	1,669,887	2.58	4,308,309
ROTC Scholarship	93,653	1,440,120	1,533,773	3.02	4,631,995
ROTC Contract	53,620	1,439,699	1,493,319	2.92	4,360,490
OCS	34,813	1,438,944	1,473,757	3.09	4,553,911

Table 39. URL Cost-Effectiveness Using Average Costs.

Community	Most Cost-Effective	Least Cost-Effective	$ Difference
SURFACE	**ROTC-Contract $585,416**	**USNA $1,382,442**	**$797,026**
SUBMARINE	**ROTC-Contract $924,693**	**USNA $1,479,621**	**$554,928**
PILOT	**USNA $3,507,689**	**OCS $4,603,709**	**$1,096,020**
NFO	**USNA $4,308,309**	**ROTC-Scholarship $4,631,995**	**$323,686**

Table 40. URL Costs Per O-4 Using Marginal Pre-Commissioning Costs.

MARGINAL PRE-AND POST-COMMISSIONING COSTS REQUIRED TO MAINTAIN STEADY STATE FLOW BY COMMUNITY AND SOURCE (IN 2002 DOLLARS).

Accession Source	Discounted Costs			Number of Accessions	Costs Per O-4
	Pre-Commissioning	Post-Commissioning	Total		
SURFACE:					
USNA	121,000	80,044	201,044	4.47	898,667
ROTC Scholarship	132,000	70,640	202,640	7.20	1,459,008
ROTC Contract	91,967	82,841	174,808	4.29	749,926
OCS	58,000	79,302	137,302	6.36	873,241
SUBMARINE:					
USNA	121,000	131,656	252,656	4.10	1,035,890
ROTC Scholarship	132,000	129,731	261,731	5.10	1,334,828
ROTC Contract	91,967	131,319	223,286	5.00	1,116,430
OCS	58,000	127,293	185,293	5.72	1,059,876
PILOT:					
USNA	121,000	1,289,253	1,410,253	2.31	3,257,684
ROTC Scholarship	132,000	1,288,707	1,420,707	2.66	3,779,081
ROTC Contract	91,967	1,287,635	1,379,602	3.20	4,414,726
OCS	58,000	1,284,301	1,342,301	3.49	4,684,630
NFO:					
USNA	121,000	1,440,660	1,561,660	2.58	4,029,083
ROTC Scholarship	132,000	1,440,120	1,572,120	3.02	4,747,802
ROTC Contract	91,967	1,439,699	1,531,666	2.92	4,472,465
OCS	58,000	1,438,944	1,496,944	3.09	4,625,557

Table 41. URL Cost-Effectiveness Using Marginal Costs.

Community	Most Cost-Effective	Least Cost-Effective	$ Difference
SURFACE	**ROTC-Contract $749,926**	**ROTC-Scholarship $1,459,008**	**$709,082**
SUBMARINE	**USNA $1,035,890**	**ROTC-Scholarship $1,334,828**	**$298,938**
PILOT	**USNA $3,257,684**	**OCS $4,684,630**	**$1,426,946**
NFO	**USNA $4,029,083**	**ROTC-Scholarship $4,747,802**	**$718,719**

VII. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

A. SUMMARY

The results of the models for both retention to the O-4 point and promotion to O-4 indicate that the effects of accession source significantly affect the probability that an officer chooses to remain on active service, and the probability that an officer promotes given he/she stays. In the second URL retention model, ROTC-Scholarship and ROTC-Contract accessions were more likely to stay to the O-4 promotion board than USNA accessions. In this same model, when USNA graduates were compared to other accessions that attended highly selective colleges and universities, ROTC-Scholarship and OCS accessions were substantially less likely to stay than USNA accessions. These results suggest that graduates of elite colleges and universities find better career opportunities in the civilian job market, and are less likely to stay in the Navy past their MSR compared to accessions from the same commissioning programs who graduate from less selective colleges (Bowman and Mehay, 2002).

In the Restricted Line retention models, ROTC-Scholarship and OCS graduates accounted for over 80% of the observations in the sample and were more likely to stay to O-4 than USNA graduates. ROTC-Contract graduates were also more likely to stay than USNA graduates. Like the results in the URL models, ROTC-Scholarship and OCS accessions who attended elite colleges and universities were substantially less likely to stay than USNA accessions. RL and URL retention models show additional similarities in the impact of prior service, technical major and APC score. In both URL and RL models, prior service had a large, positive impact on retention to O-4. Conversely, officers with technical majors and higher undergraduate GPA's were more likely to leave the Navy prior to the O-4 promotion board. These results are consistent with those of officers who attended elite colleges and universities. Technical majors appear to find better career opportunities in the civilian job market, while officers with lower undergraduate GPA's find better career opportunities in the Navy.

Analysis of the promotion results revealed different impacts of commissioning source compared to the retention models. While USNA graduates were less likely to stay

to the O-4 point, the other commissioning sources were less likely to promote to O-4 than USNA graduates. The results of the promotion models also indicate the Navy appears to earn a positive economic return on accessions from elite colleges and universities, as they are more likely to promote to O-4 than accessions from the same commissioning program but from less selective colleges.

Prior service, technical major, and college grades affect promotion differently than in the retention models. Prior service influenced promotion very little in the URL communities, but made a sizeable positive impact in the RL communities. Officers with technical majors in the Surface and Aviation communities and officers with higher GPA's were more likely to promote than officers with non-technical majors and lower GPA's. Promotion results in the RL sample also revealed that Fleet Support and Supply Corps officers were substantially less likely to promote to O-4 than RL Staff officers. These results were consistent in sign and but lower in magnitude than RL community retention differentials. Fleet Support (37.9%) and Supply Corps (34.4%) officers were less likely to stay than RL Staff officers, yet only 7.8% and 4.0%, respectively, less likely to promote than RL Staff officers.

Finally, the promotion models allowed analysis of the impact of lateral transferring from one community to another on O-4 promotion. Lateral transfers who appeared in the Aviation and Submarine communities at the O-4 board were more likely to promote than those who started their careers in these communities and remained in them. Conversely, lateral transfers into the Surface community were less likely to promote to O-4 than SWO's who started and remained in surface. The results of the RL promotion models indicate URL's with warfare qualifications who laterally transferred into RL communities were more likely to promote to O-4 than officers that spent their careers in the Restricted Line communities. This emphasizes again the value of having a warfare qualification ("pin"). URL and RL Officers with a warfare qualification appear to be more productive than those without warfare qualifications due to the extensive human capital investment made by the Navy during the warfare qualification period.

B. CONCLUSIONS

The cost-effectiveness analysis of alternate commissioning sources in this thesis provide OSD decision makers with tangible information to make future accession size and force structure decisions. The results are important and valuable because the data is not only current, but the officers represented in these data samples are currently in command and screening for command of the Navy's ships, submarines, aircraft squadrons, and shore based installations.

The cost analyses developed in Chapter VI support the conclusions of previous studies (Bowman 1995, Parcell 2001) that find USNA is the most cost-effective commissioning program for meeting future accession increases. Results in this thesis also indicate that ROTC-Contact is an accession source that has been underutilized by the Navy. In general, accessions from this source are more likely to stay and promote to O-4 than accessions from ROTC-Scholarship and OCS. Despite these results, the Navy is unable to use the ROTC-Contract program as the primary accession source for certain communities due to size limitations. The ROTC-Scholarship program is currently and should remain the primary accession source for the large number of billets in the Aviation communities.

Although ROTC-Scholarship graduates appear to cost significantly more than graduates from other accession sources in the Surface, Submarine and NFO communities, it is important to note that this thesis does not recommend decreasing the size of the ROTC Scholarship Program. The results merely suggest that the Navy should examine the USNA and ROTC-Contact programs when making future accession increases.

The results of this study also indicate that the OCS program does not retain or promote as large a percentage of career officers in either the URL or RL communities, relative to USNA and ROTC-C. Again, OCS is a valuable commissioning program to the Navy because it commissions a sizeable number of URL's at an extremely low pre-commissioning cost, and remains the primary accession source for the RL communities. However, OCS graduates left the Navy at much higher rates and were less likely to promote to O-4 than entrants from other commissioning programs.

Additionally, the results of this thesis do not support the belief that having a technical degree is critical to future success in the Navy or the O-4 promotion outcome. The results revealed technical majors were more likely to promote in four of the 11 promotion models, specifically in the Surface and Submarine communities. However, the effect of having a technical degree was quite small, generally less than 3%. Having a technical degree in the Submarine and RL communities did not impact the promotion outcome. It is also interesting that approximately 90% of the officers that stayed to the O-4 board in the Submarine community, perhaps the most technically demanding career in the Navy in terms of nuclear power, were technical majors, yet technical major was not important to the promotion outcome.

C. RECOMMENDATIONS

Two primary recommendations result from this thesis. The first is that Navy decision makers consider USNA as the primary source to meet future demand for higher accessions relative to the ROTC and OCS programs. This recommendation holds true so long as the Naval Academy is operating below its design capacity of 4,400 midshipmen.

The second recommendation is that the following data elements be collected and analyzed to estimate the impact of initial experiences of officers in the fleet while serving their minimum service obligation.

- Ship, squadron, and submarine command to include distinctions between Atlantic or Pacific Fleet
- Length of deployment
- Average time spent away from homeport during Inter-Deployment Training Cycle (IDTC)
- Time between date of commission and completion of warfare qualification
- Officer designator at separation, vice designator at last selection board on file

Analysis of these data elements is critical to the retention and promotion outcomes of the officers for Navy Officers. Retention and promotion beyond the minimum service obligation is believed to be less related to academic experience or source of accession and more likely to be related to officers' initial work experiences in the fleet (Bowman 1995). Finally, future cost-effectiveness studies should analyze Navy

officer retention and promotion to the O-5 and O-6 career points, and compare those results with Bowman's (1995) original study of senior career officers.

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF REFERENCES

1. Asch, B. J. and Warner, J. T., A Theory of Compensation and Personnel Policy, Santa Monica CA: Rand Corporation, 1994.

2. Bowman, W. R., Cost-Effectiveness of Service Academies: New Evidence from Navy Warfare Communities, United States Naval Academy Economics Department and Office of Institutional Research Working Paper, June 1995.

3. Bowman, W. R. and Mehay, S. L., "Graduate Education and Employee Performance: Evidence from Military Personnel," Economics of Education Review, Vol. 18, 1999.

4. Bowman, W. R. and Mehay, S. L., "College Quality and Employee Job Performance: Evidence from Naval Officers," Labor and Relations Review, forthcoming, 2002.

5. Branigan, Gregory A., "The Effect of Graduate Education on the Retention and Promotion of Marine Corps Officers", Thesis, Naval Postgraduate School, Monterey, California, March 2001.

6. CBO Papers, Officer Commissioning Programs: Costs and Officer Performance, Congressional Budget Office Report, June 1990.

7. Cooke and Quester, "What Characterizes Successful Enlistees in the AVF: A Study of Male Recruits in the Navy", Social Science Quarterly, June 1992.

8. Cymrot, Donald J., "Graduate Education and the Promotion of Officers," Center for Naval Analyses, CRM 86-61/March 1986.

9. Ehrenberg and Smith, Modern Labor Economics: Theory and Public Policy, 7th ed., Addison Wesley Longman Inc., 2000.

10. Hirsch, B. T. and Mehay, S. L., Evaluating the Labor Market Performance of Veterans Using a Matched Comparison Group Design, Working Paper, September 2000.

11. Mackin, et al., A Model of Navy Officer Retention. Naval Personnel Research, Studies and Technology Working Paper, 76th Annual WEA International Conference, July 8, 2001.

12. Marcus and Quester, Determinants of Labor Productivity in the Military, Center for Naval Analyses Working Paper, 1990.

13. Mehay, S. L., Analysis of Performance Data for Junior Navy and Marine Corps Officers, Office of the Secretary of Defense, Military Equal Opportunity Study, October 1995.

14. Mehay, S. L., Behavioral Models of Navy-Enlisted Retention: A Survey. U.S. Naval Postgraduate School, School of Business and Public Policy Working Paper, August 2, 2001.

15. Parcell, Ann D., "Optimizing Officer Accession Sources," Center for Naval Analyses CME D0004854.A.1/ 2 October 2001.

16. Rosen, R., "Self Selection and Education," Economics of Education, Research and Studies, Permagon Press, 1987.

17. Weilsma, Ronald, "An Analysis of Factors Affecting promotion, Retention, and Performance for USMC Officers: A Graduate Education Perspective," Thesis, Naval Postgraduate School, Monterey, California, March 1996.

18. Woodhall, M, "Earnings and Education", Economics of Education, Research and Studies, Permagon Press, 1987.

19. Woodhall, M, "Human Capital Concepts", Economics of Education, Research and Studies, Permagon Press, 1987.

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California

3. Professor Stephen L. Mehay
   Naval Postgraduate School
   Monterey, California

4. Commander Bill Hatch, Code SM/Hh
   Naval Postgraduate School
   Monterey, California

5. Professor William R. Bowman
   Economics Department
   United States Naval Academy
   Annapolis, Maryland

6. LT Joel Bernard
   Boonville, New York

7. RADM John C. Harvey, JR.
   ACNP Total Force Programming, M&I RES MGMT
   Manpower and Personnel
   Washington D.C.

8. Murrey Olmstead
   Bureau of Navy Personnel
   Navy Personnel Research, Studies, and Technology Dept
   Institute for Organizational Assessment (PERS-14)
   Millington, Tennessee

9. Murray Rowe, Director
   Navy Personnel Research, Studies and Technology
   Assistant Commander (Pers-1)
   Navy Personnel Command
   Millington, Tennessee

10. RADM Joseph Henry
Director, Military Plans and Policy Division (N13)
Manpower and Personnel
2000 Navy Pentagon (N13)
Washington D.C.

11. William Ty Cook
Norfolk, Virginia

12. Umit Gencer, 1LT
Turkish Army

13. CDR Robin L. Csuti
Officer Accessions, Plans and Policy (N131D)
DCNO (M & P)
2 Navy Annex
Washington, D.C.

14. CAPT Joan Darrah
Intelligence Community Manager (N131I)
2 Navy Annex
Washington, D.C.

15. Dr. Chris Duquette
CNA Analyst
Director, Navy Training and Education (N79)
2000 Navy Pentagon
Washington, D.C.